

AGENDA
EXECUTIVE CONFERENCE
ARS SCREWORM RESEARCH LABORATORY
Mission, Texas

January 22, 1974

✓ 8:30 a.m. Tour of APHIS Screwworm Fly Production Facility

Paul Nichols

✓ 10:30 a.m. Review of Southwestern Screwworm Eradication Program--Accomplishments and Problems

M. E. Meadows and
D. W. Anderson

✓ 11:00 a.m. History of Screwworm Research at Mission--Funding, Staffing, Objectives and Accomplishments

SWARF
XXX

R. C. Bushland

12:00 Noon

Lunch ✓

✓ 12:30 p.m. Ecology of the Screwworm in Southwestern United States and Northern Mexico--Present Knowledge and Research Needs

B. G. Hightower

✓ 2:30 p.m. Visit Sheep Pen

✓ 3:00 p.m. Field Tests--Techniques for Evaluating Adult Dispersal, Survival and Mating Capability; Discussion of 1973 Field Tests and Program Needs

C. M. Jones
O. H. Graham

January 23, 1974

✓ 8:30 a.m. ✓ Tour of Screwworm Research Laboratory Fly Sorting Demonstration

M. M. Crystal
C. M. Jones

✓ 10:00 a.m. ✓ 1974 ✓ Screwworm Genetics--Research on Genetic Markers, Cytology, Sterilization Procedures and the Establishment of New Strains for Use in the Eradication Program

B. G. Hightower
M. M. Crystal

✓ 10:30 a.m. ✓ Use of Biochemical Genetic Techniques in the Screwworm Program

G. L. Bush

✓ 11:00 a.m. ✓ Gaps in Our Knowledge of Screwworm Genetics; Proposed Expansion of ARS Colonies

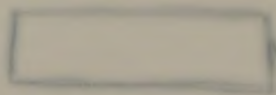
R. C. Bushland

12:30 p.m. Lunch

XXX

O. H. GRAHAM

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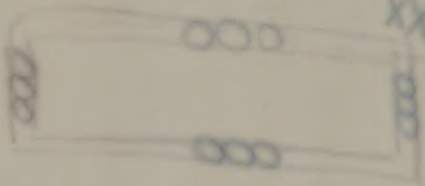
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SWAKF

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O.H. GRAHAM

January 23, 1974

✓ 1:00 p.m.

✓ Physiological Studies:

✓ Larval Nutrition.

R. E. Gingrich

✓ Some Recent Nutrition Tests and Recommendations for Continued Research

R. F. Moore, Jr.

1:40 p.m.

✓ Attractants: A review of 10 Years of Research and the Present Status of the Project

M. M. Crystal

2:30 p.m.

✓ Methods Development Programs and Their Relation to ARS Research

E. C. Corrigan

3:00 p.m.

✓ Recommendations for Research to Support Screwworm Eradication

M. E. Meadows

D. L. Williams

3:30 p.m.

Group Discussion--Assignment of Priorities

OBJECTIVES:

- a. increase fly quality
- b.
- c. decrease cost

Meadows —

a. Timing — importance of now research

1st Priority — strains

2nd

— nutrition problems

Williams — attractants —

use it as a control device to supplement sterile fly release & and chemical control —

artificial wound — use it to cause wild females to waste their eggs —
to increase egg production — use it in the rearing plant

(over)

Williams (cont)

Los Alamos contract -

- a. radar tracking
- b. improved dosimeter for attachment to the Human irradiator
- c. improved respirators
- d. mechanical sorting of screwworms
vs non-screwworms -

Puerto Rican program -

in its 3rd year, outcome doubtful -
a methods Development, field trial

In spite of Knippling's promise, no ARS participation

When do we go? on Puerto Rico program?

Floyd Smith -

a. male attractant is important -

b. Feeding device -

Bush -

mating discrimination evolved

loss of migratory instinct -

SCREWORM RESEARCH EXECUTIVE CONFERENCE
Mission, Texas
January 22-23, 1974

LIST OF PARTICIPANTS

R. J. McCracken	Associate Administrator, ARS
A. W. Cooper	Deputy Administrator, Southern Region, ARS
E. A. Taylor	Area Director, Subtropical Texas Area, ARS
L. S. Henderson	National Program Staff, ARS
M. T. Ouye	Program Analyses and Coordination Staff, ARS
P. A. Koenig	Program Planning and Review Staff, Southern Region, ARS
H. D. Petersen	Biometrician, Southern Region, ARS
J. W. Snow	Research Leader, Tobacco Insects Laboratory, Kingshill, St. Croix
G. L. Bush	Dept. of Zoology, University of Texas, Austin, Texas
R. F. Moore, Jr.	Cotton Insects Laboratory, Florence, S. C.
R. E. Gingrich	Livestock Insects Laboratory, Kerrville, Texas
O. H. Graham	Acting Research Leader, Screwworm Research, Mission, Texas
✓ A. H. Baumhover	Tobacco Insects, Oxford, N. C.
R. C. Bushland	Collaborator, Mission, Texas
✓ M. M. Crystal	Screwworm Research, Mission, Texas
B. G. Hightower	Screwworm Research, Mission, Texas
C. M. Jones	Screwworm Research, Mission, Texas
D. L. Williams	APHIS Staff, Hyattsville, Maryland
M. E. Meadows	Director, Southwestern Screwworm Eradication, Mission, Texas
D. W. Anderson	Field Operations, Southwestern Screwworm Eradication, Mission, TX
E. C. Corrigan	Methods Development, APHIS, Mission, Texas
E. H. Ahrens	Methods Development, APHIS, Mission, Texas

A. J. Graham Headquarters, SW Screwworm Eradication, APHIS, Mission, Texas
H. C. Hofmann Methods Development, APHIS, Mission, Texas
Elliott Krafur Methods Development, APHIS, Mission, Texas
Dr. Floyd Smith Field Operations, Mexican-American Commission, Mexico
Dr. Leopoldo Medina Field Operations, Mexican-American Commission, Mexico

Dr. Mc Cracken

a. OMB: ~~for~~ what is possibility of supplying ample numbers of a more satisfactory sterile male?

b. FY 1975 — Red meat package

c. Budget coordination between research and regulatory agencies

d. use of biometricians in planning and interpreting future field tests —
prediction models: ~~is~~ more input needed?
(perhaps more soil moisture data are already available than are being utilized?)

e. Can things learned from the screwworm program be applied to other programs? If so it would be justification for additional money —

f. Is the screwworm program a successful program with "second generation" or "aftermath" problems?

g. what are immediate objectives, both long and short term? (Management by objectives is current — should be reasonable, attainable and set by people assigned to the program)

h. what are the alternatives? Should be identified no matter how undesirable they may appear to us

i. Socio-economic benefits: need to be written up

g. Technical -

Short-term -

a. liquid diet utilization

b. colonies of 3 strains
(needs some clarification, full context was obvious)

c. attractants -

extramural proposal?

TDX assignment?

Art Cooper -

Engineering aspects perhaps need more attention -

Provide service to APHIS programs -

this is Southern Region policy -

There is reason for optimism -

Ed Taylor - Administrator's office has given support - People have come in on TDX to support screwworm research

Lequan Henderson -

1. attractants - (this is one package)

2. Ecology -

③ Physiology - nutrition package -

④ - Strains (Genetics) -

ANNUAL WRU REPORT AND PLAN FOR FY 1974

1. Work Reporting Unit: 401-7204-11990 Screwworm Biology and Control.
2. Location: Screwworm Research Laboratory
 Subtropical Texas Area
 ARS-USDA
 P. O. Box 986
 Mission, Texas 78572
3. Contribution of WRU to RA Visualized Technology (Objective):

 (a) The overall objective of the research is to support the current Southwestern Screwworm Eradication Program conducted by APHIS and to support the joint US-Mexico Screwworm Eradication Program now being organized.
4. Changes in Direction of Work from FY 1973 to 1974: Greater emphasis on the ecology, population dynamics, and genetics of various screwworm populations in Mexico.
5. Specific Objectives for FY 1974:

 (a) Monitor effectiveness of APHIS Screwworm Eradication Program in the US and Mexico.

 (b) Cooperate with APHIS on improving eradication techniques.

 (c) Develop new colonies of flies genetically fit for Southern Mexico.
6. Plan of Work for FY 1974:

 (a) Monitor effectiveness.

 (1) Trap screwworm flies. Ratio of wild to released will show whether wild flies are properly overflooded with sterile ones.

 (2) Determine sterility of egg masses laid by wild flies. Percentage sterility will show whether adequate numbers of competitive flies are released.

 (b) Develop improved techniques.

 (1) Study screwworm ecology in all the varied habitats of Mexico.

 (2) Collect egg masses to start colonies representing various regions of Mexico.

Henderson - (cont) -

cc. staffing -
(10 SMT's might be desirable)

401-7204-11990 Screwworm Biology and Control

6(b) Continued.

(3) Using these new colonies, study the physiology, biochemistry and genetics of Mexican flies and evaluate under laboratory and field conditions the compatibility and competitiveness of strains to be sterilized and released.

7. SMY for FY 1973 and 1974:

<u>Scientist</u>	<u>Grade- Step</u>	<u>Title</u>	<u>SMY FY 1973</u>	<u>Estimated SMY FY 1974</u>
R. C. Bushland ^{1/}	1606	Entomologist	0.8	1.0 0.5
G. W. Eddy	1507	"	0.9	0 0
O. H. Graham ^{2/}	1504 1507	"	0.8	0 0.5?
B. G. Hightower	1404	"	0.2	1.0 1.0
M. M. Crystal	1403	"	1.0	1.0 1.0
C. M. Jones	1305	"	1.0	1.0 1.0
R. R. Grabbe	1202	Chemist	1.0	1.0 0
		Total	5.7	5.0 0.3 (Snow)

^{1/} Reported for duty September 20, 1972.

^{2/} On temporary duty from Kerrville, Texas, Laboratory.

8. WRU: 401-7204-11990

<u>CRIS WORK UNITS</u>			
<u>Number</u>	<u>Title</u>	<u>Termin. Date</u>	<u>Percent of WRU</u>
<u>(Field 5)</u>	<u>(Field 7)</u>	<u>(Field 30)</u>	<u>Resources Allotted to Each CRIS</u>
HO 202	Screwworm Biology and Control	040676	100
	:0410		

9. Funds for FY 1974:

	<u>Planned Base for FY 1974 (Based on FY 1973 ARS 425)</u>	<u>Plans for FY 1974 (From Project Plan Budget Estimates)</u>
(401) Regular Funds	\$248,300	\$237,000
(404) ARS Contingency	75,000	0
Extramural Funds	44,000	0
(408) Reimbursements	0	0
(993) Misc. Contributed	0	0
Total	\$367,300	\$237,000

10. Planned Duration of this WRU: > 10 years.

11. Progress in FY 1973:

a. CRIS Work Unit Progress Report (AD 421).

(1) HO 202, Screwworm Biology and Control, 0410.

(a) With the first failure in 10 years of the Eradication Program to protect the Southwest from screwworms, research support was increased to determine the cause and develop new techniques to insure success of eradication efforts. Egg masses laid by wild flies on cattle in South Texas were found less than 40% sterile during the summer and fall of 1972. In the spring of 1973, egg masses were about 50% sterile in Tamaulipas although fly trapping showed a ratio of more than 300 sterile to 1 wild. This indicated inadequate mating competition by released flies. A new ARS strain of screwworms was established and turned over to APHIS for mass rearing for joint field trials now underway. Laboratory studies indicated mating compatibility of strains from Mexico, Puerto Rico, and Texas. Genetic and physiological studies are underway to develop more vigorous, long-lived and competitive strains.

(b) Publications.

Crystal, M. M. 1972. Chemosterilization of male screwworm flies by immersion: changes in susceptibility with time of treatment; permanence of sterility, and effect of treatment on survival. J. Med. Entomol. 9(6): 509-510.

Crystal, M. M. 1973. Chemosterilization of screwworm flies: modification of action by temperature. Environ. Entomol 2(1): 145-147.

(c) Invitational Papers and Technical Presentations.

Bushland, R. C. Leader. Symposium on the status of screw-worm research and eradication. Featured at a general session of the Annual Meeting of the Southwestern Branch, Entomological Society of America; San Antonio, Texas; February 1973.

Graham, O. H.--Paper on Field Observations in Mexico.

Eddy, G. W.--Paper on Screwworm Attractants.

Jones, C. M.--Paper on Sterility of Egg Masses Collected in South Texas.

(All presented at same meeting)

Crystal, M. M. Chemosterilization of screwworm flies: modification of action by temperature. Presented at Annual Meeting of the Entomological Society of America; Montreal, Canada. Dec. 1972.

12. Need for and Use of Additional Funds:

- a. ARS Special Fund. Under Item 9, we have listed only regular funds of \$252,000 although in 1973 we had an additional \$75,000 of special funds. It is essential that we continue to receive a minimum of \$75,000 additional support in FY 1974 in order to fulfill our commitment for field research in Mexico. In April 1974, a Mexican screwworm eradication program (80% funded by the US) is scheduled to start with the production of sterile flies at the rate of 300 million per week from a new plant to be constructed at Tuxtla Guitierrez, Chiapas, Mexico. The fly breeding colony is to be from a new stock furnished by ARS. This stock is to be genetically compatible with screwworms in southern and western Mexico where the sterile flies must compete for mates. Unless we have a budget of at least \$75,000 to supplement the regular funds, we cannot support the field work in Mexico necessary to develop that one new strain of flies needed as a minimum colony to start the Mexican production.
- b. ARS Extramural Funds: Field work shows the need for additional specialized strains to compete in unique ecological situations in isolated areas of Mexico. We need to collect egg masses from a minimum of 18 different areas in southern and western Mexico and by a special breeding program establish colonies of those 18 strains and cross breed them so that all 18 blood lines are incorporated into one new Mexican strain. This strain has to be tested for mating competitiveness in the field against local wild flies in a variety of ecological and geographical situations. We may have difficulty in adapting strains so that they can thrive in laboratory culture. Strains may fail in field trials and still newer strains will be needed. It is ARS's responsibility to furnish APHIS with colonies of new strains of competitive flies whenever new breeding stocks are needed in the Eradication Program. To be adequately budgeted for this, an additional \$50,000 is urgently needed to cover emergency field travel in Mexico and expansion of existing cooperative agreements with Mexican scientific institutions.

ANNUAL WRU REPORT AND PLAN FOR FY 1974.
401-7204-11990, Mission, Texas

HO 202. Screwworm Biology and Control, 0410.

13. FY 1974 Project Plan Budget Estimate:

- a. Location: Mission, Texas
Complete WRU Number: 401-7204-11990

b. Personal Services and Benefits:

- (1) Regular Salaries and Benefits
(2) L/A & WAE employment (Total hours)
(3) Overtime, Holiday Pay, Differentials,
and Awards

Subtotal Personal Services & Benefits

- (4) Attach WRU Salary Detail

c. Support Services:

- (1) Travel and Per Diem
(2) Transportation of things
(3) Rent, Communication, and Utilities
(4) Other Services including Reproduction
(5) Broad Form Cooperative Agreements
(6) Supplies and Materials
(7) Construction and Repairs
(8) Miscellaneous

Subtotal Support Services

d. Support Equipment

- e. Extramural Support - Research Contracts,
Grants, and General and Specific Cooperative
Agreements. Funded by base funds

Total

- f. Estimated Value of Services and Facilities
Furnished by Cooperators or Grantors in
Support of Your Research

Estimated Costs	
<u>FY 1973</u>	<u>FY 1974</u>
191,700	202,000
191,700	202,000
21,100	20,000
100	
981	1,000
725	500
14,634	8,000
660	500
	5,000 ^{1/}
38,200	35,000
18,400	
248,300	237,000

Screwworm Biology and Control
Mission, Texas
301-7204-11990

Type of Fund 401
WRU No. 11990

WRU SALARY DETAIL
(7204)

<u>Name</u>	<u>Title</u>	<u>Grade- Step</u>	<u>Status</u>	<u>MY of time on this WRU</u>	<u>Cost of Per. Service & Ben.</u>
Bushland, R. C.	Res. Ent. (Med)	GS-1606	PFT	1.0	\$37,392
Eddy, G. W.	Res. Ent.	GS-1507	PFT	0 (Retires 5/12/73)	- 34,922
Hightower, B. G.	Res. Ent.	GS-1404	PFT	1.0	27,480
Crystal, M. M.	Res. Ent.	GS-1403	PFT	1.0	24,507
Jones, C. M.	Res. Ent.	GS-1305	PFT	1.0	22,935.98
Grabbe, R. R.	Res. Chem.	GS-1202	PFT	1.0	19,217
Turner, J. P.	Bio Tech	GS-705	PFT	1.0	11,081
Lopez, E.	Bio Tech Ins	GS-704	PFT	1.0	10,755
Gonzalez, G. C.	Agrl Res Tech	GS-702	PFT	1.0	10,103
Handke, B. D.	Bio Tech	GS-506	PFT	1.0	9,222
Garcia, J. J.	Bio Tech	GS-501	PFT	1.0	7,904
Ramirez, R.	Bio Aid	GS-402	PPT	1.0	6,570
Jester, T. V.	Clerk-Typist	GS-402	PPT	1.0	7,927
Bazan, H.	Ins Res Hlpr	WG-302	TFT	1.0	<u>6,873</u>
					236,888

Ecological Studies in Support of the Screwworm Eradication Program in the Southwest

B. G. Hightower

Much of the basic information on seasonal population dynamics, requirements for survival, overwintering limitations, and behavioral traits of screwworms was developed from extensive studies by the USDA in the Southwest prior to 1945. The studies of Knippling, Parman, Lindquist, Bushland Laake, Barrett, Parish, and Deonier have provided the foundation for all subsequent ecological research on screwworms.

Since 1961, the primary objective of ecological research has been to determine the population dynamics of local screwworm populations in relation to climate, host populations, and other environmental factors. A second objective, both in the laboratory and in the field, has been to compare the characteristics of native flies with those of laboratory-adapted flies reared on artificial medium. Such characteristics included mean size, longevity, reproductive capacity, dispersal, and local distribution. In the past, studies of the effectiveness of various population densities of sterile flies from different strains or rearing regimens have been conducted in cooperation with the Methods Development Section of APHIS.

SCOPE

The present zone of screwworm control in northern Mexico is 1500 miles long and 200 to 300 miles in depth. Fortunately, climatic conditions are such that simultaneous releases over the entire area are not required. However, this part of Mexico includes mountainous terrain where life zones may range from arid tropical to alpine within a distance of 20 kilometers. When the Mexico eradication effort begins, operations will be extended over an additional 300,000 square miles of at least seasonally infested territory. Thus, the initial control zone would involve about 750,000 square miles.

The presence of 3 major mountain chains in Mexico increases the possibility that some screwworm populations are geographically isolated and may exhibit true strain differences that would influence the effectiveness of sterile male releases. This possibility must be considered in determining the best means of assuring that released sterile males will survive and compete equally with wild males in all release areas.

RESEARCH PROGRESS

One of the first requirements prior to the beginning of an eradication program in the Southwest was to determine if the previously laboratory and field tested Florida strain was adaptable to the climate in the

Southwest. Texas and Florida strains were subjected to extreme temperature and humidity regimens in the laboratory. The Florida strain survived and was used successfully in the Southwest.

2. Release-recapture tests showed that released flies tended to frequent brushy stock ponds and to disperse along wooded streams in open country. These results provided a basis for recommendations that priority be given to watercourse releases in lieu of the uniform grid releases used in the Southeast.

3. Night searches for flies dyed with fluorescent powder confirmed previous observations that young screwworm flies continue to disperse even after reaching favorable habitats.

4. The recovery of released sterile flies up to 290 km. from the release point within 14 days indicated that previous estimates of a 50-70 km. barrier zone between infested and uninfested areas would need to be revised.

5. In cooperation with APHIS and the Secretaria de Agricultura y Ganaderia, the first extensive ecological survey for screwworms was conducted in northern Mexico. Results were used in part as a guide by APHIS for "strategic" fly releases with estimated savings of \$250,000 annually compared to uniform grid release costs.

6. In cooperative field tests with APHIS and SAG in Mexico, it was demonstrated that wide swath-low release rate techniques were useful in areas with seasonally low screwworm populations, but ineffective against higher population densities.

7. It was found that in western Sonora released flies survived and crossed up to 20 kilometers of hot arid terrain to congregate in favorable habitats along river canyons.

8. Dr. R. B. Davis developed a system for determining the present and projected distribution of screwworm population based on case incidence and compatible with computer techniques. A more detailed computerized survey system incorporating his method has been proposed.

9. Criteria for some physical and behavioral characteristics of wild flies have been established and provided to APHIS. Adoption of these criteria help prevent loss of competitiveness in released male flies.

PRESENT STATUS

The cooperative screwworm laboratory at Cotaxtla, Veracruz, is no longer in operation. Trap data, field survey data, and some screwworm samples for strain studies are being obtained from Tamaulipas by Mr. Calvin Jones, from Sonora through a cooperative agreement with Monterrey Technological

Institute, and from Guerrero-Oaxaca through an agreement with Instituto Nacional de Investigaciones Agricola.

During the past year, cooperative agreements were signed with Monterrey Technological Institute, Instituto Nacional de Investigaciones Agricola and NASA for screwworm population studies in Mexico. Agreements with the latter two organizations involve the application of remote sensing techniques for predicting changes in screwworm populations based on changes in climatic conditions known to affect these populations.

RECOMMENDATIONS

1. Field studies to determine screwworm behavioral traits should be increased in the Rio Lerma Basin, Rio Balsas Basin, and the coastal plains of Guerrero and Oaxaca. If geographically isolated strains of screwworms with selective mating patterns occur in Mexico, they probably occur in one of these areas. ✓✓
2. Data decks for the construction of screwworm population indices should be revised and adapted for data acquisition for subsequent computer analysis. The feasibility of refining and adapting the contour mapping system of predicting screwworm outbreaks should be investigated in light of present General Purpose Contouring Program (GPCP) capability. ✓✓
3. The most pressing need of the ecological program is an effective attractant for wild screwworm flies, especially males. There are many questions that cannot be answered by data from liver-baited traps or pens of artificially wounded animals. ✓✓✓
4. Cooperative investigations of screwworm habitats and seasonal population fluctuations in Mexico south of the 5 border states should be intensified immediately. ✓✓✓
5. The field testing of strains of screwworm flies developed for program use should be conducted in Mexico, preferably in areas where no sterile flies have ever been released. ✓✓✓
6. Methods of tagging flies for field release need to be improved so that 2 or more kinds of flies can be released simultaneously in the same area and identified when captured. ✓✓✓

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REFERENCES TO ECOLOGICAL WORK SINCE 1961

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- Hightower, B. G. 1970. Status of screwworm eradication in the Southwest and Mexico. *Proc. 2nd Ann. Conf. on Insects, Plant Diseases, Weed, and Brush Control (Texas)* pp. 45-49.
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Field Tests: Methods for Studying Native Screwworm
Populations and Evaluating Sterile Fly Releases

C. M. Jones

The following techniques used in recent field studies are typical of those used for many years.

1. Liver-baited traps are used for capturing flies. The screwworms are separated from the total catches (A weekly catch may exceed 100,000 flies/trap.) by skilled "fly sorters." With reasonable accuracy the plant-reared flies can be distinguished from wild flies. By the use of various dyes and fluorescent powders, the flies from special releases can be identified. From the data obtained, we can draw conclusions on fly dispersion, distance and direction of travel, abundance, longevity and ratio of one strain to another or released to wild.

2. Artificially wounded animals (sheep, goats or cattle) in pens strategically located are used from which we collect screwworm egg masses. The number of eggs that do not hatch are a measure of the competitiveness of the males of the strain being released and/or the density of the native population. These animals are also used as hosts in collecting new material for study in the laboratory or used in developing new strains.

The attached summary of a study done in southern Tamaulipas during 1973 is an example of the application of most of these techniques.

Attachment

Studies on the Ecology of the Screwworm in
Tamaulipas, Mexico, 1973

Sterilized screwworm flies were released south of latitude 23° (near Aldama) in Tamaulipas between early January and April 6, 1973. Twenty-two fly traps, distributed from the coast near Tampico to Manuel, then northeast to Aldama and west to Ocampo, were in operation January 12-May 30 to obtain data on fly activity, distribution and the ratio of sterile to native females. During the period of fly releases and for one week thereafter, egg masses were collected from artificially wounded sheep at 4 locations to determine the rate of sterility. Egg masses were also collected from castrated cattle until fly releases were discontinued, and then for an additional 5 weeks in the area between Ciudad Victoria and Soto la Marina where sterile flies were still being released.

Relatively small numbers of Diptera were captured (less than 4,000 per trap) prior to the week ending February 28 and again during the week of March 28-April 4. Correspondingly small numbers of screwworms were captured during these periods and after April 11, one week following the cessation of fly drops on April 6. Weather conditions unfavorable for fly activity appeared to be responsible for the former.

The number of Diptera, other than screwworms, captured per trap varied from a low of 200 during the first week to a high of 19,300 during the week ending March 28. The number of screwworms per trap varied from 5 during the week ending January 26 to 258 during the week of peak activity ending March 28. An average of 1.5 female screwworms were captured in each of 10 traps in operation during the last 6 weeks following disappearance of released flies (Figure 1).

Seventy-five percent of the 32 egg masses collected from sheep between March 3 and April 14 were sterile, whereas, only 58% of the 60 masses collected from cattle were sterile. The sterility rate from cattle was further reduced to 38% by 33 groups of newly hatched larvae in the wounds being observed. It can be assumed that fertile egg masses were laid and that the egg cases were lost after hatching occurred (Table 1).

Screwworm Genetics: Visible Genetic Markers for Screwworm Flies

B. G. Hightower

The concept of releasing sterile flies with visible mutations in the barrier zone was proposed by Dr. Bushland prior to the initiation of the Southwestern Eradication Program. Dr. Leo LaChance and his genetics section isolated 15 different strains of screwworm flies with visible mutations. Mr. Al Baumhover outcrossed the more promising strains and conducted the laboratory studies on longevity, sexual aggressiveness, and reproductive capacity. Those strains judged suitable for further testing were reared in quantity and field tested in release-recapture studies.

A mutant strain with thickened areas at some of the wing vein junctures (speckled wing) appeared to perform well in release-recapture studies. However, most of the eye mutants were either not recovered in the field at all or the recovery pattern was obviously different from the expected results. The speckled wing strain was successfully used to evaluate dye-marking efficiency in the field.

Dr. L. W. Fletcher found several visible mutations in screwworm larvae that could have served as a means of determining if any fertile females had escaped from rearing facilities and initiated an infestation. Unfortunately, one of the more promising markers was found to occur in wild populations in Mexico, and the project was abandoned.

DEVELOPMENT AND EVALUATION OF SCREWORM STRAINS

by

Maxwell M. Crystal

The southwestern screwworm eradication program was started in February 1962 with the Florida strain which was successfully used in the Southeast. Egg-mass collections indicated that the Florida males reduced effective mating as expected.

Reports appeared of behavioral changes that occurred in other long-colonized species. Also, screwworm flies migrated into the border states from Mexico. Therefore, (1) In November 1966, a new strain was derived from Mexican screwworms and substituted for the Florida strain in the mass-rearing plant. (2) In November 1971, that strain was replaced by other screwworms of Mexican origin.

An explosive screwworm epizootic occurred in 1972. The second Mexican strain was replaced in September by a strain developed by APHIS from the flies collected in limited areas in Texas. The fourth complete replacement of the mass-reared strain in the southwestern program took place this month. This strain was a cross between screwworms collected from many areas in Texas with a strain collected from several areas in Mexico.

Other new strains are being developed. The newest Texas strain is now being completed, and a northern Mexico strain is nearing completion.

The laboratory evaluation of the fitness of screwworm strains for mass-production, irradiation, and release includes the assessment of longevity, sexual aggressiveness, mating capacity, and mating competitiveness. The Florida strain is used as a standard of comparison.

over 300 generations

Comparisons were made of the fat and glycogen reserves of males of the Florida, Old Texas, and New Texas strains as they aged. New Texas males equalled or surpassed the others in the quantity of these stored reserves.

Flight ability is being evaluated as one measure of the vigor of screwworms. A flight mill system that includes data-recording equipment showed that females were stronger fliers than males. A procedure that tests the propensity of screwworms to fly also revealed a sexual divergence in screwworm flight capability.

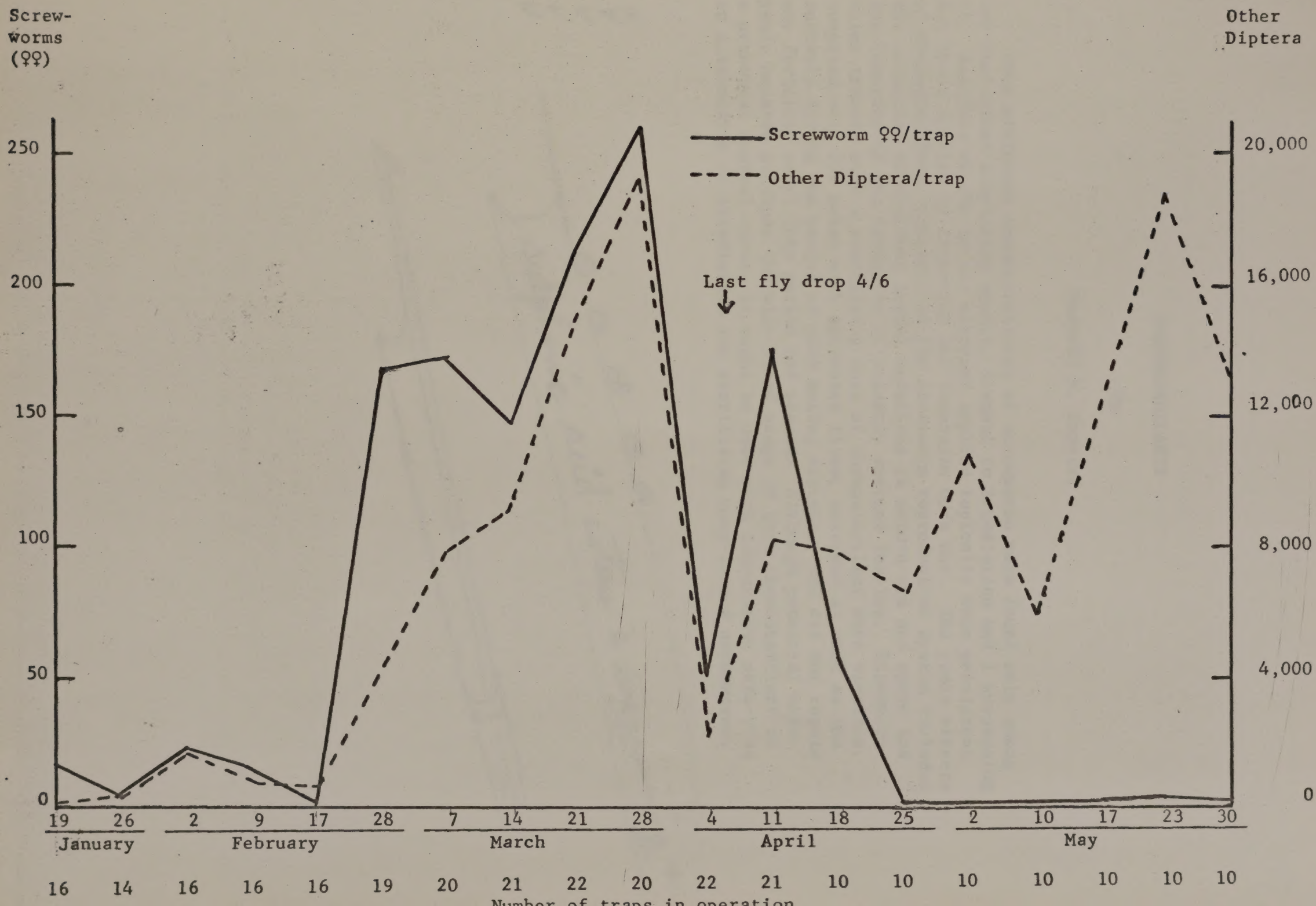
may, 1973 =

Table 1. Sterility of screwworm egg masses collected from artificially wounded sheep and castrated cattle - Southern Tamaulipas, 1973

Week ending	Number of egg masses collected from				Young larvae in wounds on cattle
	Sheep		Cattle		
	Total	Sterile	Total	Sterile	
2/17	-	-	5	2	1
2/24	0	-	2	2	1
3/3	3	0	0	-	0
3/10	6	4	8	3	2
3/17	3	2	8	2	13
3/24	2	2	3	2	1
3/31	6	6	4	4	0
4/7	7	6	9	7	7
4/14	5	4	12	6	0
4/21	-	-	0	-	0
4/28	-	-	1	1	0
5/5	-	-	6	6	8
5/12	-	-	2	0	0
Total	32	24	60	35	33
	75% sterile		58.3% sterile		

If young larvae are counted as fertile egg masses, the overall sterility would be 37.6%

Fig. 1. Average number of screwworm flies and other Diptera captured per trap - Southern Tamaulipas, 1973



CHEMOSTERILANTS

by

Maxwell M. Crystal

Four efficient chemosterilants of screwworms were found only among the biological alkylating agents, 3 equal to irradiation and 1 surpassing it. Residues of the latter compound applied topically were persistent, but those applied by injection and immersion were not. The gross effects of chemosterilant treatment on the screwworm reproductive system included the induction of dominant lethal mutations in mature ova and sperm and the lowering of the fecundity of recently emerged females. Screwworm flies treated with a sterilizing dose of chemosterilant were vigorous, competed well for mates with untreated flies, survived as well as the controls during the period of peak mating activity, and did not regain any fertility until this period had passed. Although potential mutagenic hazards preclude the widespread usage of this chemosterilant as a practical control agent, it might be used with comparative safety as an alternative to irradiation for sterilizing mass-reared screwworms.

✓
✓
✓
✓
✓

⊕ ⊕ ⊕ ⊕ ⊕
sulphonic acid esters = one promising ⊕

SCREWORM RESEARCH

The ARS Screwworm Research Laboratory at Mission, Texas, was established in FY 1963 with a budget of \$200,000. Its mission was, and still remains, research in support of the APHIS screwworm eradication program in the Southwest. For FY 1974, the tentative budget is \$256,500 to support 5 SMY. This budget has not permitted ARS research to keep pace with the APHIS screwworm eradication program that ARS is obligated to support. The APHIS screwworm eradication program started in 1963 with an annual budget of \$5 million. In FY 1973, the budget was \$9 million. With the Mexico operation included, the FY 1974 budget is approximately \$16 million. ARS responsibilities and fiscal needs to support the program have increased in the same proportion.

Eradication effort has been experiencing difficulties. Last year, there were 96,625 cases of screwworms identified in Texas on the basis of samples mailed to Mission program staff. There were, undoubtedly, many more unreported cases. This season, preceded by a cold winter, the situation is not so acute in Texas but Arizona and New Mexico are experiencing the worst screwworm year since the program started. Field tests made jointly with APHIS near Tampico and Victoria, Mexico, in the spring of 1973 showed that only 50% of the wild females mated with sterile males--even though trapping studies showed that sterile flies outnumbered wild flies more than 300 to 1. The continued increase of screwworm cases in Texas since the end of winter suggests that the released flies are not fully competitive. We do not know why.

Genetic research. There is a growing literature of insect genetics which reports that insects lose field adaptability through natural selection as they become adapted to laboratory colonization and mass rearing. Quite possibly, a loss of competitiveness among sterile screwworm flies is due to genetic deterioration in the laboratory. The new technique of isozyme analysis makes available biochemical markers to trace genetic changes in laboratory populations. Preliminary research indicates that ARS should initiate studies of biochemical variability in new field collections, and test each generation in the laboratory to assure that those field characteristics are maintained. Such research would require a full-time biochemist and support staff.

Mexico eradication program will add new problems. In November 1974, a new rearing plant is scheduled for completion at Tuxtla, Gutierrez, in the Isthmus of Tehuantepec. This plant is to produce 300 million sterile flies weekly to compete for mates against the wild population of southern Mexico. There is zero research knowledge regarding specifics on genetics, ecology, mating behavior, population density, etc., for this area. ARS has done no research south of the state of Vera Cruz and neither has anyone else. We have very little knowledge of screwworms along

Physiological research. We do not yet have a bait better than decomposing liver for APHIS to use to keep track of fly populations. Liver does not attract male screwworms. While it attracts female screwworm flies, it also attracts high numbers of ordinary blow flies. This fact alone makes it impractical to monitor eradication progress with fly traps. For efficiency in research, we need a more selective bait. To follow male fly activity, we need a male attractant.

Only one insect physiologist is now on the staff. He is fully occupied with rearing problems and other physiological tests such as flight studies, mating competitiveness, longevity, energy reserves, and fly vigor. Since these studies must be maintained full time, attractants research would benefit from the addition of another physiologist and support staff.

Screwworm problem won't fade away. During the past year, APHIS released 200 million flies per week. And yet, 100 million per week sufficed to eradicate screwworms from the U.S. and protect from reinvasion between 1963 and 1966. Even if the redoubled and dedicated effort of APHIS, combined with our limited but intense research effort, should bring about temporary relief, the problem of having to increase the number of flies released to achieve eradication still exists. Indeed, it appears to be increasing. In addition, USDA needs to prepare for all the new problems that are inevitable with the expanded program in Mexico.

Expanded Research for Screwworm

5 SMY at \$65,000 per SMY - - - - - \$325,000

New Positions Needed

2 Entomologists GS-12 (Mexico, field)
1 Entomologist GS-12 (Physiology)
1 Entomologist GS-12 (Laboratory Rearing)
1 Biochemist GS-12 (Isozyme studies)
1 Technician GS-7 (Laboratory Rearing)
3 Technicians GS-5 (Laboratory Rearing)
3 Technicians GS-3 (Laboratory Rearing) - -
3 Technicians GS-1 (Fly Sorting)
1 Laborer WB-2 (Laboratory Janitor)
1 Clerk GS-3 (Office)

*Rearing Building and Equipment - - - - - 108,300
Diet Supplies for New Breeding Colonies - - - - - 65,000

GRAND TOTAL \$498,300

*After construction, these funds will be used for additional fly diet supplies and to support expanded ecological studies in Mexico.

New Building and Equipment for Screwworm Breeding Colonies

80' x 80' building for breeding stocks:

~~(Estimates by Joe Smithy, APHIS force construction)~~

Building Shell - - - - -	\$ 50,000
Electrical, air-conditioning, plumbing - - - - -	<u>25,000</u>
Total - - - - -	\$ 75,000

Equipment:

Colony cages (APHIS specs.)	36 @ \$530 ea.	\$ 19,080
Rearing vats (APHIS specs.)	21 @ \$130 ea.	2,730
Vat racks (APHIS specs.)	7 @ \$150 ea.	1,050
Bacteriological incubators	4 @ \$300 ea.	1,200
Rearing vats (1/4 size)	12 @ \$ 75 ea.	900
Pupa holding trays	48 @ \$ 10 ea.	480
Larva capture pans	56 @ \$ 10 ea.	560
Media mixers	4 @ \$300 ea.	1,200
Refrigerators	4 @ \$250 ea.	<u>1,000</u>
Total - - - - -		\$ 28,200

Equipment for physiology research:

Bioclimatic cabinets	2 @ \$1700 ea.	\$ 3,400
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Miscellaneous rearing equipment:

Small cages	100 @ \$ 10 ea.	\$ 1,000
Larva sifters	4 @ \$ 75 ea.	300
Larva-pupa separators	4 @ \$100 ea.	<u>400</u>
Total - - - - -		\$ 1,700

GRAND TOTAL - - - - - \$108,300

RECEIVED

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
SOUTHERN REGION
SUBTROPICAL TEXAS AREA

December 20, 1973

Science
1515 Massachusettes Ave. N.W.
Washington, D. C. 20005

Editor:

John Calman and Roger H. Smith (Letters, 23 Nov. 1973, p. 775) commented adversely on the status of the Southwestern Screwworm Eradication Program. This program is conducted by the U.S. Department of Agriculture with the cooperation of livestock regulatory agencies, extension services, and grower organizations in affected U.S. states and Mexico. The program is conducted by USDA's Animal and Plant Health Inspection Service (APHIS), with research support from the Agricultural Research Service (ARS).

There could be many reasons for our recent difficulty in keeping screwworm, Cochliomyia hominivorax, populations from growing and spreading in this country. There are ecological as well as genetic and physiological considerations. Abundant rainfall for the past two years has favored screwworm increase in the warm months. An unusually mild winter in 1971-72 aided survival of this subtropical insect.

The sterile insect release program was designed on the assumption that most growers take good care of their livestock. We believed that the release of 100 million sterile flies per week would overwhelm the native flies that bred in wildlife and neglected domestic animals. Almost complete freedom from screwworms since 1964 has permitted Southwestern ranchers to save more than \$100 million (1962 dollars) annually in costs of labor and insecticides previously spent for screwworm control. When screwworms reappeared in 1972, cattlemen could not immediately return to the ranch practices of 10 years ago. Because of a lack of skilled cowboys, trained cow horses, spray pens, dipping vats, and special holding pastures, ranchers could not prevent screwworm breeding in their herds, so these became a new class of "neglected" livestock.

Starting in 1968, APHIS increased production to 200 million sterile flies weekly, but these numbers, spread over northern Mexico and the adjoining U.S. states, were inadequate for an effective barrier in 1972 and again in 1973. The situation in Texas in 1973 was much better than it was in 1972. In 1973 only an area south of Laredo and Corpus Christi suffered inadequate control. Most of the cases occurred in five counties where an uncontrolled outbreak of Gulf Coast ticks, Amblyomma maculatum, made thousands of cattle unusually susceptible to screwworms. In spite of local failures, chiefly in Texas and Arizona during the past two years, the situation was not as disastrous as Calman indicated. The 1972 infestation north of Texas was minor, occurring late in the season, and was quickly terminated by cold weather. Considering the area of the U.S. subject to screwworm losses before the sterile fly program, the vast majority of animals are still protected, to the benefit of producers, consumers and wildlife.

Although we defend the eradication program for its obvious benefits, ARS is not complacent about the need for supportive research. For those interested in references to investigations, I cite review papers (1, 2, 3, 4) by scientists who have actually done screwworm research and not merely written about it. In this letter I touch on the past year's unpublished research of Mission, Texas entomologists listed alphabetically: APHIS-- E. H. Ahrens, E. C. Corristan, A. J. Graham and H. C. Hofmann; ARS--R. C. Bushland, M. M. Crystal, G. W. Eddy, R. R. Grabbe, O. H. Graham, B. G. Hightower and C. M. Jones.

The problems in screwworm genetics cited by Smith have received attention. The APHIS screwworm breeding stock at Mission is not descended from the original Florida colony used at the beginning of the program. To prevent the loss of field adaptation through prolonged laboratory rearing, breeding stocks have been completely changed three times during the course of the program. In 1966 a strain developed from flies collected in Mexico replaced the Florida strain. In 1971 that strain was replaced by another laboratory strain of Mexican origin, and in 1972 a new strain developed from flies collected in Texas at the beginning of the outbreak became the current APHIS production strain.

We made many collections of screwworms from infested livestock at diverse locations in Texas and Mexico during 1972 and 1973 to establish laboratory populations for mating tests in cages. In all tests the laboratory strains have mated with the newly colonized flies. In competitiveness tests, the old laboratory-adapted strains of sterilized males mated more successfully with wild-type females than did fertile wild-type males.

Working jointly with the Methods Development Section of APHIS, we have conducted a series of field evaluations in Texas and Tamaulipas, Mexico. The APHIS-ARS entomological team found in release and trap-back tests that a new strain of flies (designated Tex-Mex) developed from collections made in 1972 at 18 locations in Texas and 6 in Mexico, seemed to migrate farther, faster, and survive longer than the current APHIS production strain. Both strains are now being compared for mating competitiveness against wild flies on 2,000-sq-mi. plots in South Texas.

We have brought many additional collections into the laboratory to breed for genetic and physiological studies. We are combining some of these stocks, attempting to develop a better strain.

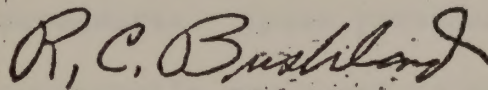
Although mild winters, rainy summers, and changed ranch practices have favored screwworms in nature, there may also have been genetic changes in the wild population. Field experiments have convinced me that our sterile males are not now mating as effectively with wild females as we might expect on the basis of tests with caged flies.

I think that the northern fringe of the wild population may have evolved mechanisms that isolate them from sterile flies in the barrier zone. Rearing the larvae on artificial media produces flies visibly different from those that grow in wounds. The sterile flies are not as large as wild flies, and their color is a different shade of blue. There are undoubtedly other deficiencies in artificially reared flies that wild flies might detect. There could also have evolved isolating mechanisms that do not involve rejection of sterile males, but rather factors in dispersal, aggregation or mating behavior that keep wild and sterile flies from intermingling at mating time. We are planning a field release in southern Mexico, where the wild population has not been exposed to sterile flies, and a similar release of sterile flies in northern Mexico to see if there is a difference in the proportion of sterile matings.

We are aided in our work at Mission by geneticists, physiologists, and chemists from other ARS laboratories at Fargo, ND; Kerrville, TX; Florence, SC; and Gainesville, FL who have come here on temporary duty to work under quarantine with fertile flies before returning to their home laboratories to continue analysis of frozen specimens and to experiment with sterile flies shipped to them by APHIS.

We are further aided by screwworm research contracts with the University of Texas at Austin (isozyme studies in population genetics); Instituto Tecnológico Y De Estudios Superiores De Monterrey, Monterrey, Mexico (studies on screwworm ecology and collection of new strains in northern Mexico); and Instituto Nacional de Investigaciones Agrícolas, Estados Unidos Mexicanos (INIA) (trapping studies, effects of weather on populations and collections of new strains in southern Mexico).

I regretfully agree with Calman that "no one has gotten to the bottom of it"--but we are digging.



R. C. Bushland
Research Leader
Screwworm Research Laboratory
Agricultural Research Service, USDA
Mission, Texas 78572

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Report on Nutritional Studies of Screwworm Larval Rearing
by ARS Cooperators

by

R. E. Gingrich
U. S. Livestock Insects Laboratory
ARS, USDA
Kerrville, Texas

Producing very large numbers of high-quality insects, which is essential for the success of the Screwworm Eradication Program, is heavily dependent on suitable larval rearing procedures. These procedures, to consistently serve the program, must be continually monitored to evaluate them for their adequacy over the long term and to quickly detect problems that occur. Changes in procedures, which are deemed beneficial for nutritional reasons, still must be compatible with certain, more or less strict, economical limitations before they can be implemented. In fact, the need for reducing costs may be the motivating factor for changes. In any case, changes in the composition of the rearing medium should be made only after their effects on the quality of the insects produced have been examined. Thus, the larval rearing aspects of the Screwworm Eradication Program are dynamic and, because of their importance, deserve frequent attention.

Throughout the Screwworm Eradication Program, changes have been made in the ingredients of the larval rearing medium. Workers in ARS and later the Methods and Development Section of the eradication organization in cooperation with ARS scientists have tested many chemicals and variously refined foodstuffs as diet ingredients. In the early 1960's, the nutritional requirements of the larvae were determined by using chemically

research started in '61

defined diets. With this basic information, ingredients could thereafter be selected for testing on the basis of their composition and their relation to the known requirements of the larvae. More recently, nutritional studies preceded and implemented the conversion to a liquid larval rearing medium.

To keep abreast of the changing situations that necessitate alterations in the rearing media, as well as to strive to improve the present rearing techniques, requires a complementary research effort. Without this type of support, we can expect to continue facing rearing crises with a disorganized attack. Furthermore, there is much to be done in the unexplored area of diet utilization, which could provide substantial cost savings.

*ARS participation was
virtually nil from 1962-1973; only
Gingren working as a consultant -
CHS*

Recent Nutritional Experiments with the Screwworm

Nutritional experiments were conducted from 10-29-73 to 12-13-73 at the Screwworm Research Laboratory, Mission, Texas by R. F. Moore, Jr., Research Entomologist from the Southeastern Cotton Insects Laboratory, Florence, S. C. The experiments were initiated as a result of the large number of screwworm cases that occurred in Texas during the summer of 1972. The stated purpose of the experiments was to produce, from a laboratory diet, a fly with the "blue color and broad thorax" of the wild fly. However, the question that was really asked was, "Were there nutritional factors involved in the rearing of the sterile flies being released that may have had a role in the incidence of screwworms in the summer of 1972?"

There are no records of a "wild" type of fly being produced on any laboratory diet, even the best ones of horsemeat, plasma and blood. The blood and plasma in these diets had always been diluted with water by a factor of 1/3 to 1/2 with a consequent reduction in the % of protein, minerals, vitamins, and other constituents of the blood. Undiluted plasma, proteins, minerals, and vitamins were added to such diets to determine if any of these affected the type of fly produced by the diets.

The pH of infested wounds has been found to be 7.2 - 7.4. In contrast, the fresh horsemeat: blood medium and hydroponic medium had a pH around 6.0 and medium with larvae, a pH of 7.0.

Eighteen diet modifications, including pH, were tested. Larval weight, stress mortality, and flight response did not show a pattern related to the modifications of the diet. However, there was a relationship between larval weight and stress mortality and there was a suggestion of a relationship between larval weight and flight response. Larvae that averaged above 65 mg survived the stress and had a greater response in the flight test than did smaller ones.

Variations in the weight of larvae from the Standard diet and observations of the diet during the experiments suggested that the availability of food and/or the accumulation of waste products limited the weight of larvae which, in turn, determined the type of fly produced from the diets.

Production of average weight larvae (70 mg) in a container with a large excess of food seemed to eliminate the availability of food as the factor. An apparatus designed to hold larvae on the horsemeat diet and permit the plasma to flow through the meat, provided a method to eliminate the waste products. One group of larvae from this type of experiment produced larvae that averaged 84.8 mg and another produced larvae that averaged 90 mg with the largest larva weighing 95 mg.

a
b
c



Conclusions

The original goal of producing a wild type of fly with a blue color and robust appearance was not accomplished, but the more general goal of determining if some nutritional changes in the rearing might produce a better quality fly was realized. The results of the studies indicated (1) that the waste products from the larvae probably limits their size, (2) that the lower limit on the size of acceptable larvae should be 65-68 mg instead of the present 60 mg, and (3) that larval size and the mortality resulting from exposure of adult flies to heat stress could give laboratory data that would have a direct relationship to survival in the field and consequently the performance of the released flies in the eradication program.

Bob Burton - Nutrition

Crystals Flight Propensity Test

M.E. meadows
Oakland ~~Ed~~ Hilton

415 - 63,500

415 - 63,500
635 - 5000
635

ATTRACTANTS
by
Maxwell M. Crystal

The most commonly used bait for trapping screwworm flies, decomposing liver, attracts only small numbers of screwworm flies and is nonspecific in effect. A more powerful and specific attractant is needed for ecological studies and for estimation of the size of the fly population in an eradication program.

Screwworm attractants research in the Southwest began in 1961 and was terminated, perhaps temporarily, in 1973. A variety of at least 1200 biological and chemical substances were tested as potential attractants. With few exceptions, none gave any evidence of significantly attracting screwworm flies. However, observations on the effects of several factors on the response of screwworms were made. More flies were captured in light than in darkness, at 30°-45°C than at 19°-27°C, of 3-4 days of age than younger, and of the female sex rather than the male.

iso-valeraldehyde

When irradiated and unirradiated flies were compared for their response to known attractants, fewer irradiated than unirradiated flies responded. Mutant strains of screwworm flies did not respond to substances that did attract normal strains. Traps that were baited with attractive materials and that already contained some screwworm flies were more attractive to other screwworms than those that contained no flies.

Different techniques for the laboratory screening of candidate attractants were developed. These methods included baited traps, usually modified from mason jars, that were placed in wire-cloth cages, on a large slowly rotating table placed in an outdoor enclosure or an inside room, in large outdoor cages, or in glass enclosures through which specially treated air was drawn. The principle of pretreating air with candidate odor was employed in a tabletop apparatus modified from those used for related species of insects.

Extracts of the condensate collected from the air of cages with thousands of virgin males contained a male pheromone that excited virgin females and stimulated many attempts to mate. Females of a newly colonized strain did not respond to the male pheromone, but a long-colonized strain continued to respond to the pheromone.

Known attractant materials elicited the greatest attraction of screwworm flies during the first 15 minutes of exposure. Progressively smaller responses were obtained for each of the next two 15 minute periods. Little or no response was observed thereafter even up to 2 hours later.

ethyl isovalerate

A study of the effects on oviposition of removing certain appendages of screwworm flies was made. More than one sensory mechanism was involved in oviposition. Sensillae on the mouthparts and antennae appeared to be more important than those on the legs. In no case was egg deposition completely prevented if the flies were allowed contact with the oviposition medium. Flies having only one antenna had difficulty in locating screwworm-infested wounds on sheep, and those having no antennae could not locate the wounds.

Bigley

Steam distillation of incubated defibrinated bovine blood yielded fractions that were highly attractive to screwworms. Six major fractions were separated by this procedure, and each of these extractions was found by extractions and chromatography to contain many components. Some of these components that were isolated were active screwworm attractants.

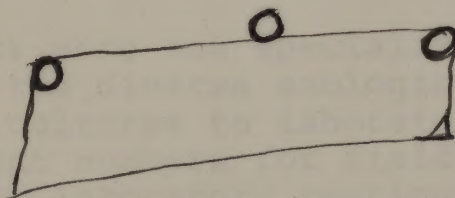


(b)

*Fresh
blood
albumin*

The importance of bacteria to the attractiveness to screwworms of incubated whole bovine blood, homogenates of screwworm larvae, and distillates of these materials was demonstrated. Certain species of bacteria inoculated into these substances prior to incubation increased the attractiveness several times.

Various compounds that were considered to be likely metabolites of proteins and fatty acids were made up in mixtures of compounds. A composite mixture of 36 acids, aromatics, alcohols, aldehydes and ketones, amines, and sulfur-containing compounds was highly attractive to screwworm flies. It surpassed blood in attractancy and was moderately attractive to males.



*a endo-
b phenol-
c para-cresol*

*sound ? female emits a sound
that is attractive to males.*

a Carlson

b Agee

A study of the effects of the addition of a small amount of a substance to a solution of a substance in a solvent. The study was conducted by adding a small amount of a substance to a solution of a substance in a solvent. The study was conducted by adding a small amount of a substance to a solution of a substance in a solvent. The study was conducted by adding a small amount of a substance to a solution of a substance in a solvent.

Figure

Figure 1
Figure 2
Figure 3

Figure 4
Figure 5

Figure 6

The study was conducted by adding a small amount of a substance to a solution of a substance in a solvent. The study was conducted by adding a small amount of a substance to a solution of a substance in a solvent. The study was conducted by adding a small amount of a substance to a solution of a substance in a solvent. The study was conducted by adding a small amount of a substance to a solution of a substance in a solvent. The study was conducted by adding a small amount of a substance to a solution of a substance in a solvent.

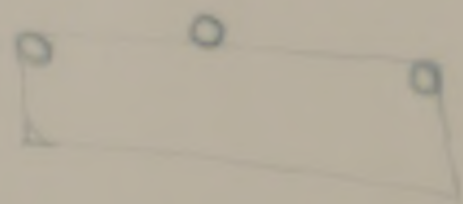


Figure 7
Figure 8
Figure 9

Figure 10
Figure 11
Figure 12

Figure 13
Figure 14

Justification for Establishing an ARS Screwworm Laboratory in Southern Mexico

The screwworm plant in Chiapas, Mexico will begin operations in April 1975 with a scheduled production of 300 million sterile flies per week. It is ARS responsibility to provide APHIS with breeding stocks of known genetic quality and scientifically tested performance. Very little is known about the biology and ecology of the screwworm in the true tropics. It is imperative that basic information about the species as it exists in southern Mexico (the region south of the 20th parallel) be obtained before initiating a sterile male release program the size of the proposed Mexico program. Biological factors such as pathogens, parasites, and predators probably replace climatic factors as the population limiting mechanisms in the tropics, but these are largely unstudied by either ARS or Mexican release agencies. Further, we have limited information regarding the feasibility of releasing current strains of screwworms in the tropics.

The sterile flies to be released in southern Mexico should be from special breeding stocks started from wild strains collected in that region. There are many rearing problems in adapting wild flies to laboratory cultures. Once a strain is in laboratory production, it must be proved effective in the field under tropical conditions against local populations of wild flies.

Very likely two or more new specialized strains will be needed to function in the diverse ecological situations of southern Mexico. To adapt new cultures to laboratory rearing and to build up strains in sufficient numbers for field tests will require at least one year. Before laboratory rearing can begin, laboratory space, similar to the specifications of the attached sketch, will be needed in Mexico.

Development of new breeding stocks in the as yet unstudied environments of southern Mexico will require a minimum of two, preferably bi-lingual, entomologists (ecology). The new field collections will need to be adapted to laboratory rearing and tested for vigor and mating competitiveness in the laboratory. One entomologist (physiologist) will be required to field-test new strains in the southern Mexico release areas.

This research must be done on-site in southern Mexico as large-scale pilot tests in a tropical environment. For APHIS

but that are largely unstudied in southern Mexico. Further, we have limited information regarding the feasibility of releasing current strains of screwworms in the tropics.

The sterile flies to be released in southern Mexico should be from special breeding stocks started from wild strains collected in that region. There are many rearing problems in adapting wild flies to laboratory cultures. Once a strain is in laboratory production, it must be proved effective in the field under tropical conditions against local populations of wild flies.

to go into a mass-production effort without one year of prior research by ARS would risk the waste of millions of dollars of program funds while discovering differences between various strain responses in new ecological situations in southern Mexico.

As a minimum, ARS should conduct a research program in Mexico that would provide additional information along the following lines:

A. Ecology

1. Correlate seasonal fluctuations in screwworm populations with a series of typical habitats.
2. Behavior of released sterile adults. Improved tagging methods.
3. Cooperation with NASA on use of remote sensing to monitor and predict population fluctuations.

B. Genetics

1. Maintenance of genetically vigorous strains of screwworms in colony.
2. Genetics of in-breeding and laboratory adaption; recognition of genetic shift and alterations.

C. Physiology

1. Methods of monitoring adult vigor.
2. Larval and adult nutrition.
3. Attractants.
4. Circadian rhythms in screwworms and their modification.
5. Endocrine systems and their role in colonization and mass release.
6. Use of electrophoretic methods to identify strains and recognize genetic shift.

Mexico Laboratory:

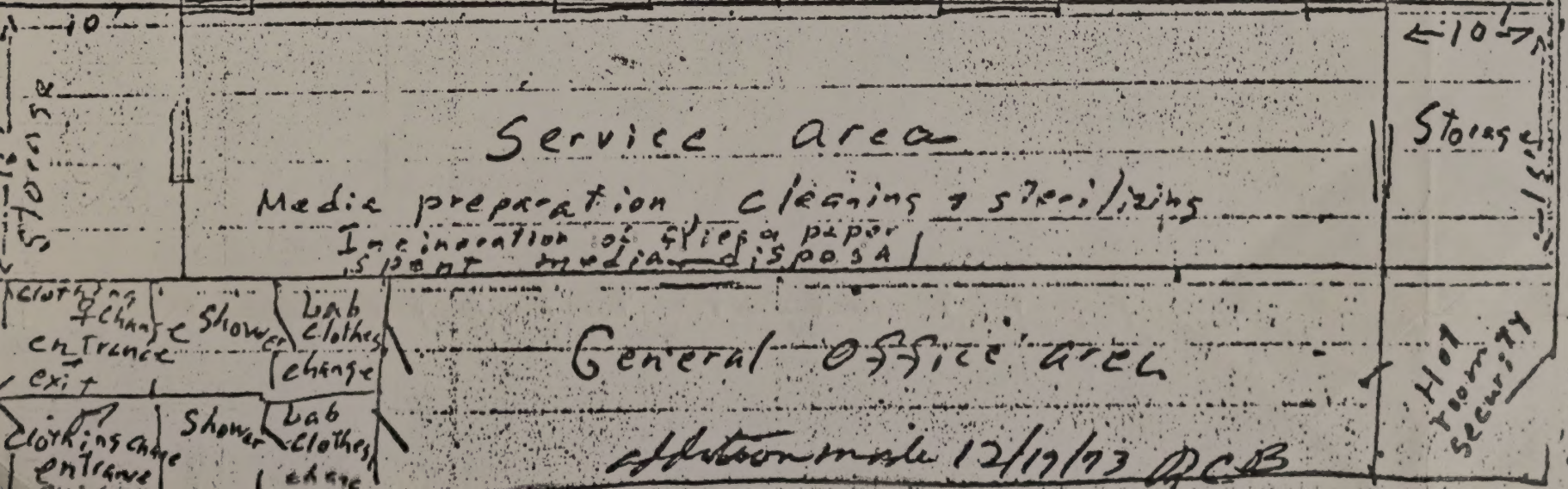
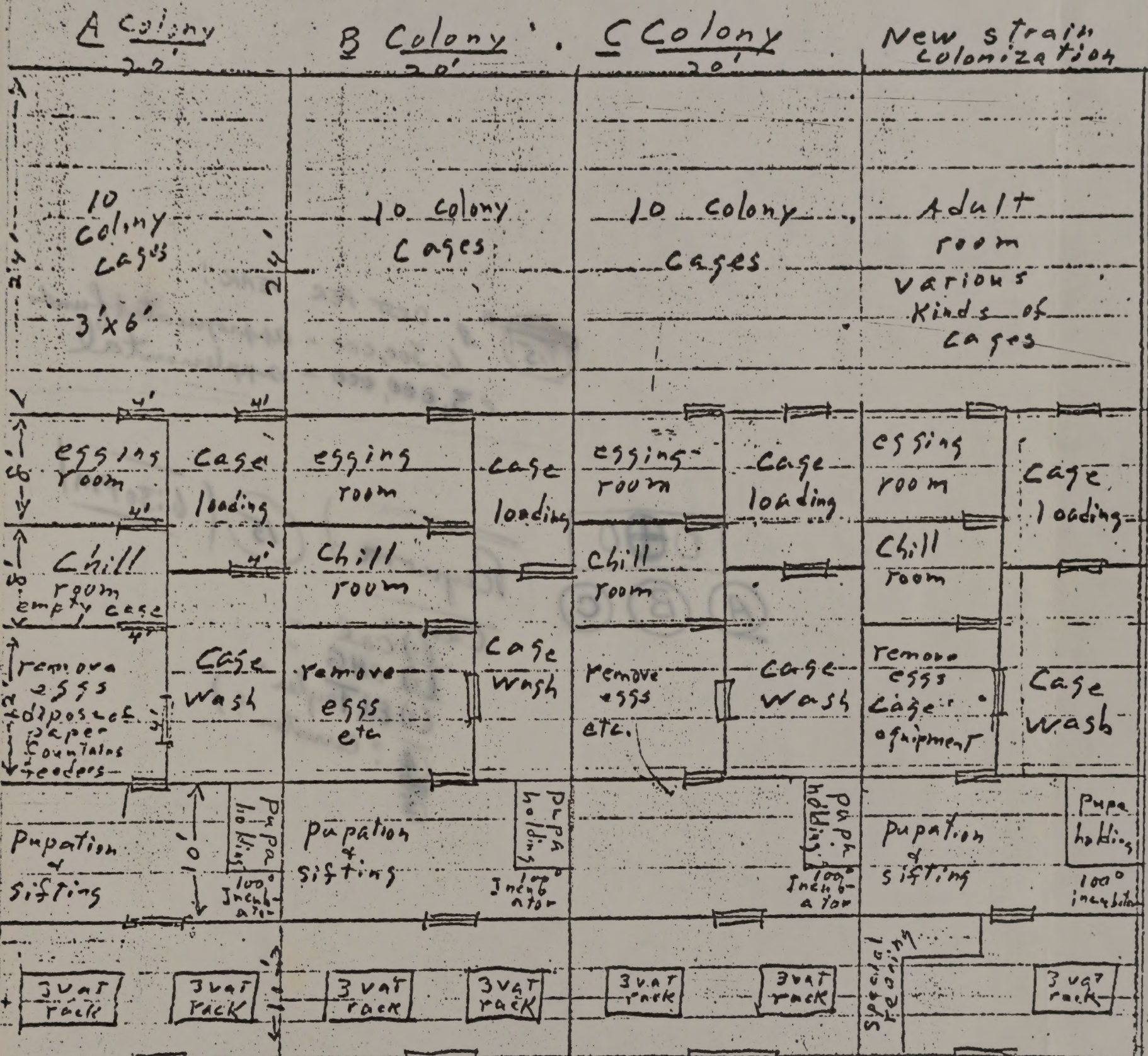
Building - 12,320 sq ft @ \$15 -----	\$ 184,800
Equipment (cages, incubators, refrigerators, etc.)\$	20,000
Sub-total -----	\$ 204,800
Vehicles: 3 air-conditioned, 4-wheel drive, pickup trucks -----	\$ 10,000
Materials and supplies -----	\$ 35,200
Grand total -----	\$ 250,000 ^{1/}

1/ Needed on a continuing basis for local support services, equipment, and supplies.

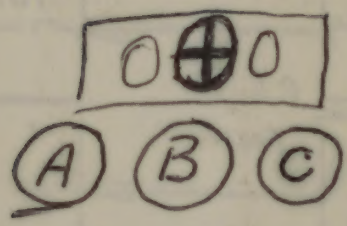
Scientific support can be provided by redirection from the proposed expanded screwworm research program at Mission, Texas. However, ARS will require nine foreign ceiling slots (OPRED slots) for the scientist and support personnel stationed at the southern Mexico laboratory.

The laboratory will not be fully equipped for full-scale operations but this additional equipment and material can be transferred when Mission, Texas laboratory phases out with the Mission APHIS program.

Addition TO rearing building 80' x 88'



~~(15)~~ COST PER YEAR:
 \$ 6,300,000 - appropriated funds
 \$ 3,000,000 - supplemental



Reynora - (15) (6:30 PM)

- Cars ✓
 (1) Cal ✓
 (2) OHG ✓
 (3) Ed Taylor ✓
 (4) ? Corristan ?
 (5)

Studies on the Ecology of the Screwworm in Tamaulipas in 1973

SUMMARY

Both wild and released screwworm flies were collected from a number of localities in Tamaulipas during 1973 to obtain data that would indicate seasonal trends in screwworm abundance and distribution and relate ratios of sterile to fertile flies to releases of sterile flies. During the time that a fly distribution center was operated in Tampico, egg masses were collected from wounded domestic animals in order to determine the percentage of wild females that were mating with sterile males. One series of fly traps was operated along a line from Cd. Victoria to La Pesca from April through December, 1973. The highest percent of sterile egg masses collected was _____, and the average for February-April was _____. Trap catches averaged _____ wild female flies/trap/week during this period. and indicated that sterile flies outnumbered wild flies _____ to 1 in the release zone. Trap catches from Municipio Ocampo in the foothills of the Sierra Madre Oriental in the western edge of the release zone contained very low numbers of sterile flies.

RESULTS

Both wild and released mosquitoes were collected from a number of localities in Tennessee during 1973 to obtain data that would indicate seasonal trends in species abundance and distribution and relative numbers of sterile to fertile flies to releases of sterile flies. During the first week a fly Harrison trap was operated in Jackson, Tennessee, and collected from mounted domestic animals in order to determine the percentage of wild females that were mating with sterile males. One series of fly traps was operated along a line from Mt. Vernon to the Indian River through December, 1973. The highest percent of sterile eggs was collected during the month of February-April was _____, and the average for February-April was _____. The percent of sterile eggs was _____ with _____ during this period. and indicated that sterile flies outnumbered wild flies _____ to 1 in the release area. Trap catches from multiple locations in the localities of the 1973 release showed that the seasonal cycle of the release area contained very few releases of sterile flies.

BHG

Field Tests: Methods for Studying Native Screwworm
Populations and Evaluating Sterile Fly Releases

C. M. Jones

The following techniques used in recent field studies are typical of those used for many years.

1. Liver-baited traps are used for capturing flies. The screwworms are separated from the total catches (A weekly catch may exceed 100,000 flies/trap.) by skilled "fly sorters." With reasonable accuracy the plant-reared flies can be distinguished from wild flies. By the use of various dyes and fluorescent powders, the flies from special releases can be identified. From the data obtained, we can draw conclusions on fly dispersion, distance and direction of travel, abundance, longevity and ratio of one strain to another or released to wild.

2. Artificially wounded animals (sheep, goats or cattle) in pens strategically located are used from which we collect screwworm egg masses. The number of eggs that do not hatch are a measure of the competitiveness of the males of the strain being released and/or the density of the native population. These animals are also used as hosts in collecting new material for study in the laboratory or used in developing new strains.

The attached summary of a study done in southern Tamsulipas during 1973 is an example of the application of most of these techniques.

Attachment

Field Tests: Methods for Studying Native Screwworm
Populations and Evaluating Sterile Fly Releases

G. M. Jones

The following techniques used in recent field studies are typical of those used for many years.

1. Liver-baited traps are used for capturing flies. The screwworms are separated from the total catches (A weekly catch may exceed 100,000 flies/trap) by skinned "fly sorters." With reasonable accuracy the plant-reared flies can be distinguished from wild flies. By the use of various dyes and fluorescent powders, the flies from special releases can be identified. From the data obtained, we can draw conclusions on fly dispersion, distance and direction of travel, abundance, longevity and ratio of one strain to another or released to wild.

2. Artificially wounded animals (sheep, goats or cattle) in pens strategically located are used from which we collect screwworm egg masses. The number of eggs that do not hatch are a measure of the competitiveness of the males of the strain being released and/or the density of the native population. These animals are also used as hosts in collecting new material for study in the laboratory or used in developing new strains.

The attached summary of a study done in southern Tamaslipas during 1973 is an example of the application of most of these techniques.

Attachment

Studies on the Ecology of the Screwworm in
Tamaulipas, Mexico, 1973

Sterilized screwworm flies were released south of latitude 23° (near Aldama) in Tamaulipas between early January and April 6, 1973. Twenty-two fly traps, distributed from the coast near Tampico to Manuel, then northeast to Aldama and west to Ocampo, were in operation January 12-May 30 to obtain data on fly activity, distribution and the ratio of sterile to native females. During the period of fly releases and for one week thereafter, egg masses were collected from artificially wounded sheep at 4 locations to determine the rate of sterility. Egg masses were also collected from castrated cattle until fly releases were discontinued, and then for an additional 5 weeks in the area between Ciudad Victoria and Soto la Marina where sterile flies were still being released.

Relatively small numbers of Diptera were captured (less than 4,000 per trap) prior to the week ending February 28 and again during the week of March 28-April 4. Correspondingly small numbers of screwworms were captured during these periods and after April 11, one week following the cessation of fly drops on April 6. Weather conditions unfavorable for fly activity appeared to be responsible for the former.

The number of Diptera, other than screwworms, captured per trap varied from a low of 200 during the first week to a high of 19,300 during the week ending March 28. The number of screwworms per trap varied from 5 during the week ending January 26 to 258 during the week of peak activity ending March 28. An average of 1.5 female screwworms were captured in each of 10 traps in operation during the last 6 weeks following disappearance of released flies (Figure 1).

Seventy-five percent of the 32 egg masses collected from sheep between March 3 and April 14 were sterile, whereas, only 58% of the 60 masses collected from cattle were sterile. The sterility rate from cattle was further reduced to 38% by 33 groups of newly hatched larvae in the wounds being observed. It can be assumed that fertile egg masses were laid and that the egg cases were lost after hatching occurred (Table 1).

Studies on the Ecology of the Screwworm in
Tamaulipas, Mexico, 1973

Sterilized screwworm flies were released south of latitude 23° (near Alamo) in Tamaulipas between early January and April 6, 1973. Twenty-two fly traps, distributed from the coast near Tampico to Matamoros, then northeast to Alamo and west to Ocampo, were in operation January 12-May 30 to obtain data on fly activity, distribution and the ratio of sterile to native females. During the period of fly releases and for one week thereafter, egg masses were collected from artificially wounded sheep at 4 locations to determine the rate of sterility. Egg masses were also collected from castrated cattle until fly releases were discontinued, and then for an additional 5 weeks in the area between Ciudad Victoria and Soto la Marina where sterile flies were still being released.

Relatively small numbers of *Diptera* were captured (less than 4,000 per trap) prior to the week ending February 28 and again during the week of March 28-April 4. Correspondingly small numbers of screwworms were captured during these periods and after April 11, one week following the cessation of fly drops on April 6. Weather conditions unfavorable for fly activity appeared to be responsible for the former.

The number of *Diptera*, other than screwworms, captured per trap varied from a low of 200 during the first week to a high of 19,300 during the week ending March 28. The number of screwworms per trap varied from 2 during the week ending January 26 to 328 during the week of peak activity ending March 28. An average of 1.5 female screwworms were captured in each of 10 traps in operation during the last 6 weeks following disappearance of released flies (Figure 1).

Seventy-five percent of the 32 egg masses collected from sheep between March 3 and April 14 were sterile, whereas, only 28% of the 60 masses collected from cattle were sterile. The sterility rate from cattle was further reduced to 38% by 33 groups of newly hatched larvae in the wounds being observed. It can be assumed that fertile egg masses were laid and that the egg cases were lost after hatching occurred (Table 1).

SCREWORM RESEARCH EXECUTIVE CONFERENCE
Mission, Texas
January 22-23, 1974

LIST OF PARTICIPANTS

R. J. McCracken	Associate Administrator, ARS
A. W. Cooper	Deputy Administrator, Southern Region, ARS
E. A. Taylor	Area Director, Subtropical Texas Area, ARS
L. S. Henderson	National Program Staff, ARS
M. T. Ouye	Program Analyses and Coordination Staff, ARS
P. A. Koenig	Program Planning and Review Staff, Southern Region, ARS
H. D. Petersen	Biometrician, Southern Region, ARS
J. W. Snow	Research Leader, Tobacco Insects Laboratory, Kingshill, St. Croix
G. L. Bush	Dept. of Zoology, University of Texas, Austin, Texas
R. F. Moore, Jr.	Cotton Insects Laboratory, Florence, S. C.
R. E. Gingrich	Livestock Insects Laboratory, Kerrville, Texas
O. H. Graham	Acting Research Leader, Screwworm Research, Mission, Texas
A. H. Baumhover	Tobacco Insects, Oxford, N. C.
R. C. Bushland	Collaborator, Mission, Texas
M. M. Crystal	Screwworm Research, Mission, Texas
B. G. Hightower	Screwworm Research, Mission, Texas
C. M. Jones	Screwworm Research, Mission, Texas
D. L. Williams	APHIS Staff, Hyattsville, Maryland
M. E. Meadows	Director, Southwestern Screwworm Eradication, Mission, Texas
D. W. Anderson	Field Operations, Southwestern Screwworm Eradication, Mission, TX
E. C. Corrigan	Methods Development, APHIS, Mission, Texas
E. H. Ahrens	Methods Development, APHIS, Mission, Texas

A. J. Graham	Headquarters, SW Screwworm Eradication, APHIS, Mission, Texas
H. C. Hofmann	Methods Development, APHIS, Mission, Texas
Elliott Krafur	Methods Development, APHIS, Mission, Texas
Dr. Floyd Smith	Field Operations, Mexican-American Commission, Mexico
Dr. Leopoldo Medina	Field Operations, Mexican-American Commission, Mexico

1. J. J. Jones	2. J. J. Jones
3. J. J. Jones	4. J. J. Jones
5. J. J. Jones	6. J. J. Jones
7. J. J. Jones	8. J. J. Jones
9. J. J. Jones	10. J. J. Jones
11. J. J. Jones	12. J. J. Jones

January 10, 1974

SCREWORM RESEARCH NEEDS

1. Screwworm fly strain research and coordinated methods development generally comparing the fly behavior in the "wild" and in the laboratory. Study systems for maintaining and incorporating new strains into the production operation as necessary.
2. Research directed toward the securing of a screwworm fly attractant for (1) field studies, and (2) oviposition in the laboratory and the field.
3. Basic biology and ecology of field behavior of native screwworms, including food sources, mating habits, distribution patterns, migration, and population dynamics.
4. Nutritional studies--Dietary studies should be conducted for mass rearing and for colonization. Qualitative dietary studies should be performed.
5. Continue research for a universal pesticide. This is one which would be effective against screwworms, ticks, mites, cattle grubs, lice, or a combination of some of these.

Ja

Houmigan	Williams
Schubert	Gartman
Klingsporn	Martin
Knapp	Stacy

last

7

Subject: Screwworm Research Needs

To: T. W. Edminster, Administrator
Agricultural Research Service

The Entomology Research group at Mission, Texas, proposed the expansion of research at that station to augment the present program along with specific studies to provide answers to technical questions being raised about the program in Mexico. As a result of these requests, a meeting was held in Dr. Mulhern's office on September 17, 1973. It was the consensus of all the research and regulatory people present that there was a need for additional research. APHIS requests that ARS carry out the following research.

I. Study the Different Strains of Screwworm Flies in Nature. ✓

A. The entomologists felt a need to study the genetics of the screwworm strains being used for sterile fly release and to develop and colonize new strains from Mexico which could be introduced into sterile fly production. These strains should have broad genetic variability which is naturally found in native strains of the screwworm. This may be important to the mating performance of released flies with the native fly populations.

II. An Attractant. ✓

A. We have long recognized the need for more efficient attractants. The following are three examples of specific attractant needs:

1. An attractant to lure screwworm flies into screwworm field traps to test released fly strains and evaluate program effectiveness.

2. An oviposition attractant (artificial wound) which can be used in field studies.

3. An improved oviposition attractant for use in fly colonization in the laboratory and the production plant.

III. Basic Biology and Ecology of Screwworms. ✓

Example: Where and when do the screwworm flies mate in nature and what kind of nectar or food do they prefer or need.

IV. Nutritional Studies. ✓

A. Further qualitative dietary studies should be performed.

B. Since no quantitative nutritional requirements have yet been developed for screwworm larvae production diets, this should be undertaken. Such information will be valuable in the development of strains that are larger, have a more natural appearance, and which demonstrate superior performance in the field.

V. Universal Pesticide. ✓

We would like to have one that could be used against screwworms, ticks, mites, and cattle grubs which would be more effective than the present pesticides. This should be one which could be used with minimal residue problems and for which a field test is available.

cc:

Dr. Lyman Henderson, ARS, Beltsville, Md.

Dr. R. C. Bushland, ARS, Mission, Texas

Dr. M. E. Meadows, APHIS-VS, Mission, Texas

Dr. N. L. Meyer, APHIS-VS, Mexico City, Mexico

APHIS:VS:DLWilliams/SCGartman:smc 10/3/73 ext. 68233

→ J. G. Garton #

Proposed Research, Methods Development, and Quality Control Needs.

1. Develop methods for determining the fitness of Plant strains.
 - a. Develop New large cages for this purpose that require the flies to fly over partitions to mate.
2. Conduct tests on the mating compatibility of strains from different parts of Mexico.
 - a. Sterility results from Puerto Rico and mating tests conducted between the ARS and APHIS strains indicate possible existence of Mating Incompatibility.
3. When conducting mating tests between different strains use flies of similar sexual maturity instead of similar age.
 - a. Do research on the feasibility of this.
4. Do research on the use of Stress to secure genetic improvement of strains.
5. Do research on the use of stress to maintain the fitness of plant strains.
6. Results on sterility from comparison of the Puerto Rican and Mexican strains and of the Tex-Mex and APHIS strains indicate a significant change in fitness in the course of 6 months to a years production in the Plant.
 - a. Consider changing the plant strain every 6 months to a year.
7. Do research into the difference between keeping several separate strains from different parts of Mexico in production as compared to having one composite strain.

1. The first session of the meeting was devoted to the presentation of the reports of the various committees and subcommittees. The reports were presented in a series of papers, which were then discussed in a general session.

2. The second session was devoted to the presentation of the reports of the various committees and subcommittees. The reports were presented in a series of papers, which were then discussed in a general session.

3. The third session was devoted to the presentation of the reports of the various committees and subcommittees. The reports were presented in a series of papers, which were then discussed in a general session.

4. The fourth session was devoted to the presentation of the reports of the various committees and subcommittees. The reports were presented in a series of papers, which were then discussed in a general session.

5. The fifth session was devoted to the presentation of the reports of the various committees and subcommittees. The reports were presented in a series of papers, which were then discussed in a general session.

6. The sixth session was devoted to the presentation of the reports of the various committees and subcommittees. The reports were presented in a series of papers, which were then discussed in a general session.

7. The seventh session was devoted to the presentation of the reports of the various committees and subcommittees. The reports were presented in a series of papers, which were then discussed in a general session.

8. The eighth session was devoted to the presentation of the reports of the various committees and subcommittees. The reports were presented in a series of papers, which were then discussed in a general session.

9. The ninth session was devoted to the presentation of the reports of the various committees and subcommittees. The reports were presented in a series of papers, which were then discussed in a general session.

10. The tenth session was devoted to the presentation of the reports of the various committees and subcommittees. The reports were presented in a series of papers, which were then discussed in a general session.

DRAFT

AGENDA FOR EXECUTIVE CONFERENCE ARS SCREWORM RESEARCH LABORATORY MISSION, TEXAS

January 22 1974

*Paul Nichols
Frank Dudley*

08:30 AM	Tour of APHIS Rearing Facility	
10:30 AM	Review of Southwestern Screwworm Eradication Program--Accomplishments and Problems	Drs. Meadows and Anderson
11:00 AM	History of Screwworm Research at Mission--Funding, Staffing, Objectives and Accomplishments	Dr. R. C. Bushland
12:00 AM	Lunch	
12:30 PM	Ecology of the Screwworm in Southwestern United States and Northern Mexico--Present Knowledge and Research Needs	Dr. B. G. Hightower
02:30 PM	Visit Sheep Pen	<i>FRANK GONZALEZ</i>
03:00 PM	Field Tests--Techniques for Evaluating Adult Dispersal, Survival and Mating Capability; Discussion of 1973 Field Tests and Program Needs	C. M. Jones O. H. Graham

January 23, 1974

08:30 AM	Tour of Screwworm Research Laboratory	Dr. M. M. Crystal
<i>9:50 AM</i>	<i>Fly Sorting Demonstration</i>	<i>C.M. Jones</i>
10:00 AM	Screwworm Genetics--Research on Genetic Markers, Cytology, Sterilization Procedures and the Establishment of New Strains for Use in the Eradication Program	B. G. Hightower M. M. Crystal
	Use of Biochemical Genetic Techniques in the Screwworm Program	Guy Bush
	Gaps in Our Knowledge of Screwworm Genetics; Proposed Expansion of ARS Colonies	R. C. Bushland
12:30 PM	Lunch	
01:00 PM	Physiological Studies	
	Larval Nutrition and its Relation to Adult Appearance, Vigor and Behavior	R. E. Gingrich

07:30 AM

AGENDA FOR EXECUTIVE COMMITTEE
AND BOARD OF DIRECTORS
January 1970

Paul Walker
John Walker

January 1970

Topic of APHS Meeting Facility

9:30 AM

Review of Southwestern Research
Program - Economics and Planning

10:30 AM

Review of Southwestern Research of Mining
During Steady Objectives and Action

11:30 AM

Discussion

Lunch

12:30 PM

Geology of the Southwest in Southwestern
United States and Northern Mexico
Present Knowledge and Research Needs

1:30 PM

Visit Sheep Pen

2:30 PM

Field Tests - Techniques for Research
Physical, Survival and Mining
Discussion of 1970 Field Tests and
Results

3:30 PM

January 1970

Field Sorting Demonstration

9:30 AM

Southwestern Research on Genetics
Biology, Ecology, and the
and the relationship of the
in the Southwest

Use of Microchemical Analysis
in the Southwest

10:30 AM

Review of the Southwest
Geological Research of the Southwest

11:30 AM

Lunch

12:30 PM

Physiological Research

1:30 PM

~~Field Sorting Demonstration~~

9:30 AM

Some Recent Nutrition Tests and Recommendations for Continued Research

Ray Moore

01:40 PM

Attractants: A Review of 10 Years of Research and the Present Status of the Project

M. M. Crystal

02:30 PM

Methods Development Programs and Their Relation to ARS Research

E. C. Corrigan

03:00 PM

Recommendations for Research to Support Screwworm Eradication

D.L. WILLIAMS

M. E. Meadows

~~APRIS STIFF~~

Drs. Villaseñor and Meyer

03:30 PM

Group Discussion--Assignment of Priorities

Ray Moore	Some Recent Nutrition Tests and Recommendations for Continued Research	01:40 PM
M. M. Givens	Abstracts: A Review of 10 Years of Research and the Present Status of the Project	02:30 PM
E. C. Corstian	Methods Development Progress and Their Relation to ARS Research	03:00 PM
M. E. Meadows Dr. Villanor and Meyer	Recommendations for Research to Support Screwworm Eradication D.L. Williams	03:30 PM
	Group Discussion--Assignment of Priorities	

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SCREWORM RESEARCH EXECUTIVE CONFERENCE
Mission, Texas
January 22-23, 1974

LIST OF PARTICIPANTS

T R. J. McCracken	Associate Administrator, ARS
T A. W. Cooper	Deputy Administrator, Southern Region, ARS
E. A. Taylor	Director, Subtropical Texas Area, ARS
T L. S. Henderson	National Program Staff, ARS
T M. T. Ouye	Program Analyses & Coordination Staff, ARS
T Paul Koenig	Program Planning & Review Staff, Southern Region, ARS
T Del Var Petersen	Biometrician, Western Region, ARS
T J. W. Snow	Research Leader, Tobacco Insects Laboratory, Kingshill, St. Croix
Guy L. Bush	Dept of Zoology, University of Texas, Austin
T R. F. Moore, Jr.	Cotton Insects Laboratory, Florence, S.C.
T R. E. Gingrich	Livestock Insects Laboratory, Kerrville, TX
T O. H. Graham	Livestock Insects Laboratory, Kerrville, TX
T A. H. Baumhover	Tobacco Insects, Oxford, N. C.
R. C. Bushland	Screwworm Research Laboratory, Mission, TX
M. M. Crystal	Screwworm Research Laboratory, Mission, TX
B. G. Hightower	Screwworm Research Laboratory, Mission, TX
C. M. Jones	Screwworm Research Laboratory, Mission, TX
J. L. Hourrigan	APHIS Staff, Hyattsville
T D. L. Williams	APHIS Staff, Hyattsville
M. E. Meadows	Director, Southwestern Screwworm Eradication, Mission
D. W. Anderson	Field Operations, Southwestern Screwworm Eradication

12 need rides -
Dr. Suigo } cars
Ouye }

Graham } cars
moore }
gingrich }

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Participants

2

E. C. Corristan	Methods Development, APHIS
E. H. Ahrens	Methods Development, APHIS
A. J. Graham	Headquarters, SW Screwworm Eradication, APHIS
H. C. Hofmann	Methods Development, APHIS
Elliott Krafur	Methods Development, APHIS

~~Dr. M. A. Villaseñor~~ ~~Director, Comisión Mexico-American for the~~
~~Eradication of the Screwworm~~

~~Dr. Norvan Meyer~~ ~~Co-Director~~ " " "

Dr. Leopoldo Medina Field Opns., " "

Dr. Floyd Smith " " "

VISIT TO TAMAULIPAS

A. W. Cooper ~~APHIS?~~

E. A. Taylor

M. T. Ouye

W. G. Hart

R. C. Bushland

O. H. Graham

C. M. Jones

~~Willis Jones?~~

~~Norvan Meyer?~~

D. L. WILLIAMS

Leopoldo Medina

Floyd Smith

Dieter Eubelin - Monterrey Tech

José G. Tavaroz -

IN MEXICO

Jim Parker

Tom Andre'

Ashley Taylor

Jesús Rodriguez

Ing. Canales

Dr. J. H. Brown	Dr. J. H. Brown
Dr. J. H. Brown	Dr. J. H. Brown
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Dr. J. H. Brown	Dr. J. H. Brown
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Tour -

(DST?)

Lv Reynosa -	0800?
ar Gral. Teran - (115 miles)	1100 1000 AM
Lv "	12:00 -
ar Montemorelos (Restaurant Casino)	12:15 -
Lv "	1:30 PM ✓
ar Cd Victoria (130 miles)	4:30 pm
\$(Motel Panoramico)	
Lv " 258515	5:00 PM
to Canon El novillo	
to Union Regional	7:00 PM ?

Lv Panoramico	0800 (Standard Time)
ar Rcho. San Pedro	0830

Sheep pen
return to Lr motel
Lr "

11:00 AM

mosca Pinta
Bill Nelson

12:30 PM

a.

b.

Box lunch

Ar McAllen

drinking water
soft drinks

(DST)

Tom

0800

11:00 AM

12:00

12:17

1:30 PM

2:30 PM

La Negra

7:00 PM

Floyd Smith
Dr. Medina

11:00 AM

12:30 PM

Espinosa - 10 sheep

Rcho. San Pedro
castrations ✓
sheep pen ✓

(A) trap
canyon

rooms
Panoramico
125

D
R
A
F
T

SCREWORM RESEARCH EXECUTIVE CONFERENCE
Mission, Texas
January 22-23, 1974

LIST OF PARTICIPANTS

R. J. McCracken	Associate Administrator, ARS
A. W. Cooper	Deputy Administrator, Southern Region, ARS
E. A. Taylor	Director, Subtropical Texas Area, ARS
L. S. Henderson	National Program Staff, ARS
M. T. Ouye	Program Analyses & Coordination Staff, ARS
Paul Koenig	Program Planning & Review Staff, Southern Region, ARS
Del Var Petersen	Biometrician, Western Region, ARS
J. W. Snow	Research Leader, Tobacco Insects Laboratory, Kingshill, St. Croix
Guy L. Bush	Dept of Zoology, University of Texas, Austin
R. F. Moore, Jr.	Cotton Insects Laboratory, Florence, S.C.
R. E. Gingrich	Livestock Insects Laboratory, Kerrville, TX
O. H. Graham	Livestock Insects Laboratory, Kerrville, TX
A. H. Baumhover	Tobacco Insects, Oxford, N. C.
R. C. Bushland	Screwworm Research Laboratory, Mission, TX
M. M. Crystal	Screwworm Research Laboratory, Mission, TX
B. G. Hightower	Screwworm Research Laboratory, Mission, TX
C. M. Jones	Screwworm Research Laboratory, Mission, TX
J. L. Hourrigan	APHIS Staff, Hyattsville
D. L. Williams	APHIS Staff, Hyattsville
M. E. Meadows	Director, Southwestern Screwworm Eradication, Mission
D. W. Anderson	Field Operations, Southwestern Screwworm Eradication

Participants

2

E. C. Corristan	Methods Development, APHIS
E. H. Ahrens	Methods Development, APHIS
A. J. Graham	Headquarters, SW Screwworm Eradication, APHIS
H. C. Hofmann	Methods Development, APHIS
Elliott Krafur	Methods Development, APHIS

Dr. M. A. Villasenor	Director, Comision Mexico-American for the Eradication of the Screwworm
Dr. Norvan Meyer	Co-Director " " "

Dr. Leopoldo medina - Field Operations, "

Dr. Floyd Smith - " , "

VISIT TO TAMAULIPAS

A. W. Cooper	APHIS Staff?
E. A. Taylor	
M. T. Ouye	
W. G. Hart	
R. C. Bushland	
O. H. Graham	
C. M. Jones	

~~Villasenor?~~

~~Norvan Meyer?~~

D.L. WILLIAMS , APHIS, Hyattsville, Maryland

Floyd Smith - Comision Mexico - Americana para la Eradicacion
del Gusano Barenador, Mexico, D.F.

Leopoldo medina - " "

Jose G. Tavaroz - " "

Screwworm Research Executive Conference:

Those attending the Executive Conference on Jan. 22-23:

R. J. McCracken

A. W. Cooper

Paul Koenig - PPR

L. S. Henderson

M. T. Ouye

J. W. Snow

Guy Bush ✓

R. F. Moore ✓

Del Var Petersen ✓

R. E. Gingrich ✓

APHIS

Mr. E. Meadows -

Don Williams -

Ed. Corrigan

A. J. Graham

Chris. Hoffman

Elmer Abrams

Those going to Cd. Victoria on Jan. 24-25:

~~R. J. McCracken?~~

A. W. Cooper

E. A. Taylor

M. T. Ouye, W. G. Hart

O. H. Graham

R. C. Bushland

B. G. Hightower

Calvin Jones

or

Dr. Graham to make arrangements for dinner at Reynosa for the evening of January 22.

Area Office to make room reservations at Sheraton Fairway, McAllen for attendees.

Dr. Graham to furnish Mr. Taylor a list of all Mexican officials with whom the above group will meet with. This list is to include: name, title, and affiliation. This list is being requested by Dr. Cooper prior to the conference. Also, Dr. Cooper would like to know if Dr. Sifuentes will be at Cd. Victoria.

Juanita to get information from Dr. Graham concerning best place for room reservations at Cd. Victoria and make the reservations.

~~Reynosa~~, Panoramico

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Ecological Studies in Support of the Screwworm Eradication Program in the Southwest

B. G. Hightower

Much of the basic information on seasonal population dynamics, requirements for survival, overwintering limitations, and behavioral traits of screwworms was developed from extensive studies by the USDA in the Southwest prior to 1945. The studies of Knipling, Parman, Lindquist, Bushland Laake, Barrett, Parish, and Deonier have provided the foundation for all subsequent ecological research on screwworms.

Since 1961, the primary objective of ecological research has been to determine the population dynamics of local screwworm populations in relation to climate, host populations, and other environmental factors. A second objective, both in the laboratory and in the field, has been to compare the characteristics of native flies with those of laboratory-adapted flies reared on artificial medium. Such characteristics included mean size, longevity, reproductive capacity, dispersal, and local distribution. In the past, studies of the effectiveness of various population densities of sterile flies from different strains or rearing regimens have been conducted in cooperation with the Methods Development Section of APHIS.

SCOPE

The present zone of screwworm control in northern Mexico is 1500 miles long and 200 to 300 miles in depth. Fortunately, climatic conditions are such that simultaneous releases over the entire area are not required. However, this part of Mexico includes mountainous terrain where life zones may range from arid tropical to alpine within a distance of 20 kilometers. When the Mexico eradication effort begins, operations will be extended over an additional 300,000 square miles of at least seasonally infested territory. Thus, the initial control zone would involve about 750,000 square miles.

The presence of 3 major mountain chains in Mexico increases the possibility that some screwworm populations are geographically isolated and may exhibit true strain differences that would influence the effectiveness of sterile male releases. This possibility must be considered in determining the best means of assuring that released sterile males will survive and compete equally with wild males in all release areas.

RESEARCH PROGRESS

One of the first requirements prior to the beginning of an eradication program in the Southwest was to determine if the previously laboratory and field tested Florida strain was adaptable to the climate in the

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RESEARCH PROGRESS

One of the first requirements prior to the beginning of an eradication program in the Southwest was to determine if the previously laboratory and field tested Florida strain was adaptable to the climate in the

Southwest. Texas and Florida strains were subjected to extreme temperature and humidity regimens in the laboratory. The Florida strain survived and was used successfully in the Southwest.

2. Release-recapture tests showed that released flies tended to frequent brushy stock ponds and to disperse along wooded streams in open country. These results provided a basis for recommendations that priority be given to watercourse releases in lieu of the uniform grid releases used in the Southeast.

3. Night searches for flies dyed with fluorescent powder confirmed previous observations that young screwworm flies continue to disperse even after reaching favorable habitats.

4. The recovery of released sterile flies up to 290 km. from the release point within 14 days indicated that previous estimates of a 50-70 km. barrier zone between infested and uninfested areas would need to be revised.

5. In cooperation with APHIS and the Secretaria de Agricultura y Ganaderia, the first extensive ecological survey for screwworms was conducted in northern Mexico. Results were used in part as a guide by APHIS for "strategic" fly releases with estimated savings of \$250,000 annually compared to uniform grid release costs.

6. In cooperative field tests with APHIS and SAG in Mexico, it was demonstrated that wide swath-low release rate techniques were useful in areas with seasonally low screwworm populations, but ineffective against higher population densities.

7. It was found that in western Sonora released flies survived and crossed up to 20 kilometers of hot arid terrain to congregate in favorable habitats along river canyons.

8. Dr. R. B. Davis developed a system for determining the present and projected distribution of screwworm population based on case incidence and compatible with computer techniques. A more detailed computerized survey system incorporating his method has been proposed.

9. Criteria for some physical and behavioral characteristics of wild flies have been established and provided to APHIS. Adoption of these criteria help prevent loss of competitiveness in released male flies.

PRESENT STATUS

The cooperative screwworm laboratory at Cotaxtla, Veracruz, is no longer in operation. Trap data, field survey data, and some screwworm samples for strain studies are being obtained from Tamaulipas by Mr. Calvin Jones, from Sonora through a cooperative agreement with Monterrey Technological

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3. Night searches for flies dyed with fluorescent powder confirmed previous observations that young screwworm flies continue to disperse even after reaching favorable habitats.

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PRESENT STATUS

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Institute, and from Guerrero-Oaxaca through an agreement with Instituto Nacional de Investigaciones Agricola.

During the past year, cooperative agreements were signed with Monterrey Technological Institute, Instituto Nacional de Investigaciones Agricola and NASA for screwworm population studies in Mexico. Agreements with the latter two organizations involve the application of remote sensing techniques for predicting changes in screwworm populations based on changes in climatic conditions known to affect these populations.

RECOMMENDATIONS

1. Field studies to determine screwworm behavioral traits should be increased in the Rio Lerma Basin, Rio Balsas Basin, and the coastal plains of Guerrero and Oaxaca. If geographically isolated strains of screwworms with selective mating patterns occur in Mexico, they probably occur in one of these areas.
2. Data decks for the construction of screwworm population indices should be revised and adapted for data acquisition for subsequent computer analysis. The feasibility of refining and adapting the contour mapping system of predicting screwworm outbreaks should be investigated in light of present General Purpose Contouring Program (GPCP) capability.
3. The most pressing need of the ecological program is an effective attractant for wild screwworm flies, especially males. There are many questions that cannot be answered by data from liver-baited traps or pens of artificially wounded animals.
4. Cooperative investigations of screwworm habitats and seasonal population fluctuations in Mexico south of the 5 border states should be intensified immediately.
5. The field testing of strains of screwworm flies developed for program use should be conducted in Mexico, preferably in areas where no sterile flies have ever been released.
6. Methods of tagging flies for field release need to be improved so that 2 or more kinds of flies can be released simultaneously in the same area and identified when captured.

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Screwworm Genetics: Visible Genetic Markers for Screwworm Flies

B. G. Hightower

The concept of releasing sterile flies with visible mutations in the barrier zone was proposed by Dr. Bushland prior to the initiation of the Southwestern Eradication Program. Dr. Leo LaChance and his genetics section isolated 15 different strains of screwworm flies with visible mutations. Mr. Al Baumhover outcrossed the more promising strains and conducted the laboratory studies on longevity, sexual aggressiveness, and reproductive capacity. Those strains judged suitable for further testing were reared in quantity and field tested in release-recapture studies.

A mutant strain with thickened areas at some of the wing vein junctures (speckled wing) appeared to perform well in release-recapture studies. However, most of the eye mutants were either not recovered in the field at all or the recovery pattern was obviously different from the expected results. The speckled wing strain was successfully used to evaluate dye-marking efficiency in the field.

Dr. L. W. Fletcher found several visible mutations in screwworm larvae that could have served as a means of determining if any fertile females had escaped from rearing facilities and initiated an infestation. Unfortunately, one of the more promising markers was found to occur in wild populations in Mexico, and the project was abandoned.

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CHC

ATTRACTANTS
by
Maxwell M. Crystal

The most commonly used bait for trapping screwworm flies, decomposing liver, attracts only small numbers of screwworm flies and is nonspecific in effect. A more powerful and specific attractant is needed for ecological studies and for estimation of the size of the fly population in an eradication program.

Screwworm attractants research in the Southwest began in 1961 and was terminated, perhaps temporarily, in 1973. A variety of at least 1200 biological and chemical substances were tested as potential attractants. With few exceptions, none gave any evidence of significantly attracting screwworm flies. However, observations on the effects of several factors on the response of screwworms were made. More flies were captured in light than in darkness, at 30°-45°C than at 19°-27°C, of 3-4 days of age than younger, and of the female sex rather than the male.

When irradiated and unirradiated flies were compared for their response to known attractants, fewer irradiated than unirradiated flies responded. Mutant strains of screwworm flies did not respond to substances that did attract normal strains. Traps that were baited with attractive materials and that already contained some screwworm flies were more attractive to other screwworms than those that contained no flies.

Different techniques for the laboratory screening of candidate attractants were developed. These methods included baited traps, usually modified from mason jars, that were placed in wire-cloth cages, on a large slowly rotating table placed in an outdoor enclosure or an inside room, in large outdoor cages, or in glass enclosures through which specially treated air was drawn. The principle of pretreating air with candidate odor was employed in a tabletop apparatus modified from those used for related species of insects.

Extracts of the condensate collected from the air of cages with thousands of virgin males contained a male pheromone that excited virgin females and stimulated many attempts to mate. Females of a newly colonized strain did not respond to the male pheromone, but a long-colonized strain continued to respond to the pheromone.

Known attractant materials elicited the greatest attraction of screwworm flies during the first 15 minutes of exposure. Progressively smaller responses were obtained for each of the next two 15 minute periods. Little or no response was observed thereafter even up to 2 hours later.

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A study of the effects on oviposition of removing certain appendages of screwworm flies was made. More than one sensory mechanism was involved in oviposition. Sensillae on the mouthparts and antennae appeared to be more important than those on the legs. In no case was egg deposition completely prevented if the flies were allowed contact with the oviposition medium. Flies having only one antenna had difficulty in locating screwworm-infested wounds on sheep, and those having no antennae could not locate the wounds.

Steam distillation of incubated defibrinated bovine blood yielded fractions that were highly attractive to screwworms. Six major fractions were separated by this procedure, and each of these extractions was found by extractions and chromatography to contain many components. Some of these components that were isolated were active screwworm attractants.

The importance of bacteria to the attractiveness to screwworms of incubated whole bovine blood, homogenates of screwworm larvae, and distillates of these materials was demonstrated. Certain species of bacteria inoculated into these substances prior to incubation increased the attractiveness several times.

Various compounds that were considered to be likely metabolites of proteins and fatty acids were made up in mixtures of compounds. A composite mixture of 36 acids, aromatics, alcohols, aldehydes and ketones, amines, and sulfur-containing compounds was highly attractive to screwworm flies. It surpassed blood in attractancy and was moderately attractive to males.

OHG

CHEMOSTERILANTS

by

Maxwell M. Crystal

Four efficient chemosterilants of screwworms were found only among the biological alkylating agents, 3 equal to irradiation and 1 surpassing it. Residues of the latter compound applied topically were persistent, but those applied by injection and immersion were not. The gross effects of chemosterilant treatment on the screwworm reproductive system included the induction of dominant lethal mutations in mature ova and sperm and the lowering of the fecundity of recently emerged females. Screwworm flies treated with a sterilizing dose of chemosterilant were vigorous, competed well for mates with untreated flies, survived as well as the controls during the period of peak mating activity, and did not regain any fertility until this period had passed. Although potential mutagenic hazards preclude the widespread usage of this chemosterilant as a practical control agent, it might be used with comparative safety as an alternative to irradiation for sterilizing mass-reared screwworms.

CHLOROTERILANTS

by

Maxwell M. Grayson

Four efficient chemosterilants of screwworms were found only among the biological alkylating agents, 3 equal to irradiation and 1 surpassing it. Residues of the latter compound applied topically were persistent, but those applied by injection and immersion were not. The gross effects of chemosterilant treatment on the screwworm reproductive system included the induction of dominant lethal mutations in mature ova and sperm and the lowering of the fecundity of recently emerged females. Screwworm flies treated with a sterilizing dose of chemosterilant were vigorous, competed well for mates with untreated flies, survived as well as the controls during the period of peak mating activity, and did not regain any fertility until this period had passed. Although potential malarial hazards preclude the widespread usage of this chemosterilant as a practical control agent, it might be used with comparative safety as an alternative to irradiation for sterilizing mass-reared screwworms.

Recent Nutritional Experiments with the Screwworm

Nutritional experiments were conducted from 10-29-73 to 12-13-73 at the Screwworm Research Laboratory, Mission, Texas by R. F. Moore, Jr., Research Entomologist from the Southeastern Cotton Insects Laboratory, Florence, S. C. The experiments were initiated as a result of the large number of screwworm cases that occurred in Texas during the summer of 1972. The stated purpose of the experiments was to produce, from a laboratory diet, a fly with the "blue color and broad thorax" of the wild fly. However, the question that was really asked was, "Were there nutritional factors involved in the rearing of the sterile flies being released that may have had a role in the incidence of screwworms in the summer of 1972?"

There are no records of a "wild" type of fly being produced on any laboratory diet, even the best ones of horsemeat, plasma and blood. The blood and plasma in these diets had always been diluted with water by a factor of 1/3 to 1/2 with a consequent reduction in the % of protein, minerals, vitamins, and other constituents of the blood. Undiluted plasma, proteins, minerals, and vitamins were added to such diets to determine if any of these affected the type of fly produced by the diets.

The pH of infested wounds has been found to be 7.2 - 7.4. In contrast, the fresh horsemeat: blood medium and hydroponic medium had a pH around 6.0 and medium with larvae, a pH of 7.0.

Eighteen diet modifications, including pH, were tested. Larval weight, stress mortality, and flight response did not show a pattern related to the modifications of the diet. However, there was a relationship between larval weight and stress mortality and there was a suggestion of a relationship between larval weight and flight response. Larvae that averaged above 65 mg survived the stress and had a greater response in the flight test than did smaller ones.

Variations in the weight of larvae from the Standard diet and observations of the diet during the experiments suggested that the availability of food and/or the accumulation of waste products limited the weight of larvae which, in turn, determined the type of fly produced from the diets.

Production of average weight larvae (70 mg) in a container with a large excess of food seemed to eliminate the availability of food as the factor. An apparatus designed to hold larvae on the horsemeat diet and permit the plasma to flow through the meat, provided a method to eliminate the waste products. One group of larvae from this type of experiment produced larvae that averaged 84.8 mg and another produced larvae that averaged 90 mg with the largest larva weighing 95 mg.

Conclusions

The original goal of producing a wild type of fly with a blue color and robust appearance was not accomplished, but the more general goal of determining if some nutritional changes in the rearing might produce a better quality fly was realized. The results of the studies indicated (1) that the waste products from the larvae probably limits their size, (2) that the lower limit on the size of acceptable larvae should be 65-68 mg instead of the present 60 mg, and (3) that larval size and the mortality resulting from exposure of adult flies to heat stress could give laboratory data that would have a direct relationship to survival in the field and consequently the performance of the released flies in the eradication program.

Field Tests: Methods for Studying Native Screwworm
Populations and Evaluating Sterile Fly Releases

C. M. Jones

The following techniques used in recent field studies are typical of those used for many years.

1. Liver-baited traps are used for capturing flies. The screwworms are separated from the total catches (A weekly catch may exceed 100,000 flies/trap.) by skilled "fly sorters." With reasonable accuracy the plant-reared flies can be distinguished from wild flies. By the use of various dyes and fluorescent powders, the flies from special releases can be identified. From the data obtained, we can draw conclusions on fly dispersion, distance and direction of travel, abundance, longevity and ratio of one strain to another or released to wild.

2. Artificially wounded animals (sheep, goats or cattle) in pens strategically located are used from which we collect screwworm egg masses. The number of eggs that do not hatch are a measure of the competitiveness of the males of the strain being released and/or the density of the native population. These animals are also used as hosts in collecting new material for study in the laboratory or used in developing new strains.

The attached summary of a study done in southern Tamaulipas during 1973 is an example of the application of most of these techniques.

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Studies on the Ecology of the Screwworm in Tamaulipas, Mexico, 1973

Sterilized screwworm flies were released south of latitude 23° (near Aldama) in Tamaulipas between early January and April 6, 1973. Twenty-two fly traps, distributed from the coast near Tampico to Manuel, then northeast to Aldama and west to Ocampo, were in operation January 12-May 30 to obtain data on fly activity, distribution and the ratio of sterile to native females. During the period of fly releases and for one week thereafter, egg masses were collected from artificially wounded sheep at 4 locations to determine the rate of sterility. Egg masses were also collected from castrated cattle until fly releases were discontinued, and then for an additional 5 weeks in the area between Ciudad Victoria and Soto la Marina where sterile flies were still being released.

Relatively small numbers of Diptera were captured (less than 4,000 per trap) prior to the week ending February 28 and again during the week of March 28-April 4. Correspondingly small numbers of screwworms were captured during these periods and after April 11, one week following the cessation of fly drops on April 6. Weather conditions unfavorable for fly activity appeared to be responsible for the former.

The number of Diptera, other than screwworms, captured per trap varied from a low of 200 during the first week to a high of 19,300 during the week ending March 28. The number of screwworms per trap varied from 5 during the week ending January 26 to 258 during the week of peak activity ending March 28. An average of 1.5 female screwworms were captured in each of 10 traps in operation during the last 6 weeks following disappearance of released flies (Figure 1).

Seventy-five percent of the 32 egg masses collected from sheep between March 3 and April 14 were sterile, whereas, only 58% of the 60 masses collected from cattle were sterile. The sterility rate from cattle was further reduced to 38% by 33 groups of newly hatched larvae in the wounds being observed. It can be assumed that fertile egg masses were laid and that the egg cases were lost after hatching occurred (Table 1).

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6 HG

DEVELOPMENT AND EVALUATION OF SCREWORM STRAINS

by

Maxwell M. Crystal

The southwestern screwworm eradication program was started in February 1962 with the Florida strain which was successfully used in the Southeast. Egg-mass collections indicated that the Florida males reduced effective mating as expected.

Reports appeared of behavioral changes that occurred in other long-colonized species. Also, screwworm flies migrated into the border states from Mexico. Therefore, in November 1966, a new strain was derived from Mexican screwworms and substituted for the Florida strain in the mass-rearing plant. In November 1971, that strain was replaced by other screwworms of Mexican origin.

An explosive screwworm epizootic occurred in 1972. The second Mexican strain was replaced in September by a strain developed by APHIS from the flies collected in limited areas in Texas. The fourth complete replacement of the mass-reared strain in the southwestern program took place this month. This strain was a cross between screwworms collected from many areas in Texas with a strain collected from several areas in Mexico.

Other new strains are being developed. The newest Texas strain is now being completed, and a northern Mexico strain is nearing completion.

The laboratory evaluation of the fitness of screwworm strains for mass-production, irradiation, and release includes the assessment of longevity, sexual aggressiveness, mating capacity, and mating competitiveness. The Florida strain is used as a standard of comparison.

Comparisons were made of the fat and glycogen reserves of males of the Florida, Old Texas, and New Texas strains as they aged. New Texas males equalled or surpassed the others in the quantity of these stored reserves.

Flight ability is being evaluated as one measure of the vigor of screwworms. A flight mill system that includes data-recording equipment showed that females were stronger fliers than males. A procedure that tests the propensity of screwworms to fly also revealed a sexual divergence in screwworm flight capability.

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HISTORY OF THE SCREWORM RESEARCH LABORATORY

R. C. Bushland

The USDA has monopolized screwworm research since investigations began at the Southern Field Crops Laboratory in Dallas in 1913. In the 1920's screwworm research was expanded by the establishment of a special laboratory at Uvalde. In 1937 most of the Dallas screwworm research was transferred to Menard. In 1947 all of the livestock insects research (except for Oregon) was consolidated at Kerrville.

In FY 1962, the Kerrville Laboratory retained a budget of \$209,000 for its general program and had a new appropriation of \$200,000 for screwworm research in support of the forthcoming Southwestern Screwworm Eradication Program.

With that new budget, seven senior scientists were assigned to screwworm research. The areas of research and responsible scientists were as follows:

1. Mating Competitiveness (Baumhover)
2. Genetics and Radiation Biology (LaChance)
3. Ecology (Hightower)
4. Attractants (Fletcher)
5. Chemosterilants (Crystal)
6. Cytological Effects of Radiation and Chemicals (Riemann)
7. Larval Nutrition (Gingrich)

When the screwworm eradication plant was opened at Mission in July, 1962, the screwworm research team was transferred to the present location. This unit functioned as a sublaboratory of Kerrville until the reorganization of ARS.

Some of the studies that were initiated in FY 1962 have been completed or are no longer urgent in the light of today's knowledge, but others have grown in complexity and importance. So overall needs for screwworm research are greater than ever.

We have a unique responsibility in screwworm research. When one considers research on other insects of similar economic importance--whether those insects affect man, animals or crops--it is evident that the USDA is engaged

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in research rivalry with universities, agricultural experiment stations, or industrial laboratories. But screwworm research is different--since 1913, we have done it all. Practically everything that is known about screwworm biology and control is a result of USDA research. Because we have had exclusive responsibility for screwworm research for 60 years, we have a special obligation to continue in our traditional position of leadership.

